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ABSTRACT

Three environmental education units relating environmental concerns to elementary school students' own experiences are described in this materials packet. Emphasis is on helping students become more sensitive to human and personal dimensions of environmental upset. Designed to teach children about themselves and their air, water, and land environments in an increasingly interdependent world, the units focus on natural disasters such as earthquakes, floods, weather upsets, pollution, and scarcity of natural resources. Each unit specifies objectives, materials, grade levels, and teaching procedures; supplies history briefs of related materials; defines terms where necessary; and provides a summary and footnotes. Activities include simulation of an earthquake and a simple watershed, class discussion of environment-oriented articles from the newspaper, cutting out natural objects from construction paper, testing for bacteria, making models of geographic areas, and listening as the teacher reads stories of natural disasters. Several articles which appeared in UNICEF News and a wall sheet that are part of this kit are available from the publisher but are not included on the microfiche. (Author/DB)

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Teaching About the Child and World Environment

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TEACHING ABOUT THE CHILD AND WORLD ENVIRONMENT

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TEACHER'S GUIDE TO THE CHILD AND WORLD ENVIRONMENT

This teaching kit is designed to help you teach children about themselves and their environment in this increasingly interdependent world. Although environmental education is a content area, and thus can be most useful in the science curriculum, it should be recognized that environmental studies and their human and social applications are highly relevant to the total curriculum. Webster's dictionary defines environment as being "all the conditions, circumstances, and influences surrounding and affecting the development of an organism." Few concepts are more basic to understanding global interdependence than the concept of environment.

The environment in which the child, as an organism, lives and learns is also an affective climate or learning atmosphere in which frames of reference and organizing concepts become structures in the mind of the child. We are not surprised to learn that those structures which have the poorest foundations, materials, and construction most often are first to fall in an earthquake. Should we not give even greater consideration to insuring a strong foundation in the development of the child? Are we providing children with the kind of physical and psychological environment in which they can grow to become healthy, responsible citizens of this world? Are we doing enough to help our children build strength of character and human concern to enable them to better withstand the quakes and tremors of life in this increasingly complex and interdependent world?

Winston Churchill once said: "First we shape our buildings and thereafter they shape us." It would seem equally valid to say, "First we shape our concepts and thereafter they shape us." Although the dynamic character of the concept is less rigid than the structures Churchill had in mind, the process of shaping our thinking and our behavior operates similarly. Until the building is replaced or changed in structure, our behavior is shaped by the way it organizes our activity. We move through its hallways and enter and exit its doorways according to the way we shaped it in the first place. Likewise, until the conceptual structure is replaced or changed, our behavior is shaped by the way it organizes our thinking activity into certain channels, too often limiting our access to perspectives no broader than those based on the concepts we built in the first place.

Therefore, in order to meet our responsibilities in teaching the child about world environment, we must be careful to first build such instruction on a strong, broad-based curricular foundation. The Environmental Education Task Force of the New York State Education Department acknowledged this in its Handbook of Environmental Education Strategies. Rejecting the idea of environmental education as a static base for disseminating factual knowledge within the bounds of one particular area of the curriculum, the Task Force suggests that environmental concepts should be viewed as "common denominators for the integration of environmental concerns into the subject matter areas....There is no 'right subject matter province' of environment." [1]

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The following list of concepts is taken from "Environmental Concepts and the Curriculum," a section of the handbook described above. Although in the handbook they are keyed to examples and strategies in seven subject areas of the curriculum from grades 5-12, the Task Force suggests that "the rationale for each of these strategies and some of the examples should readily suggest environmental learning experience for younger children." [2]

1.	Survival	...continuing life (or existence) in the presence of difficult conditions...survival depends upon the ability of an organism to adjust to its environment...
2.	Interdependence	...mutual reliance...an organism cannot live alone...
3.	Scarcity	...smallness of quantity in relation to needs...as populations increase, competition for resources necessitates the establishment of priorities...
4.	Recycling	--continuous feedback for reuse...in nature, the endless, circular flow of many elements.
5.	Planning	...detailing a program of action...decisions concerning the future must be based on long-term environmental benefits...
6.	Optimism	...anticipating the best possible outcome... man has the capacity to make this the best of all possible worlds...
7.	Interaction	--reciprocal action or influence...exchange, stimulation, or influence between or among organisms (including man) within their environment and/or among their respective environments.
8.	Right vs. Responsibility	...satisfying the requirements of suitability vs. accountability...man has exercised his right with little regard for his responsibility to the environment...
9.	Social Forces	...agents of change in society...society must be moved to insure the preservation of the environment...
10.	Change	--dynamic modification...the continuous alteration of previously existing forms, styles, and substances. [3]

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The three units and supplementary materials in this teaching kit are not intended to be comprehensive. They do, however, represent the broad concerns for our air, water, and land environment, and they recognize the interrelated concepts upon which environmental learnings must be based. For example, earthquakes are studied as natural forces in our land environment, but the problems of overgrazing and deforestation of hills and mountainsides are caused by human activities. Thus, the damage to a given environment from disastrous landslides is often the result of natural and human causes.

As this kit is studied and used, keep in mind these ten concepts which are themselves all interrelated. Emphasize ways in which our interdependence or mutual reliance for our survival is ultimately related to the social forces which must move to insure the preservation of our environment.

Although this concept of the interrelatedness of all things may seem complex -- and by many measures and definitions it certainly is -- it is also a very simple and basic concept. Piaget in The Language and Thought of the Child writes:

> There is in the child a tendency towards justification at all costs, a spontaneous belief that everything is connected with everything else and that everything can be explained by everything else. [4]

Compare the following more complex statement regarding food production and our environment with the child's simple belief that "everything is connected with everything else." John and Elizabeth Moore, Co-Editors of "Science/Society Case Study," write:

> One cannot think about increasing worldwide levels of food production without considering...the land, fertilizers, energy, technology, pesticides and the...possible health effects of the pesticides..., possible pollution of groundwater and local bodies of water from runoff of fertilizers and/or pesticides and air pollution by dust ...from dry and eroding farm land. Then, of course, there are the problems of economics;...transportation and storage facilities; seed production, development, and preservation of genetic varieties; and a marketing system.
>
> This is an impressively long list....But the point is clear: Issues do not represent clear and simple problems; rather they are a tangle of interrelated problems. Surely no one can be an expert in all areas, but an awareness of the breadth of issues and an attempt to consider them is essential. Failure to do so will only result in additional problems. [5]

This concept is a vital one to learn whether approached from the child's rather simplistic viewpoint or that of the mature science writer who tries to analyze the multiplier effect of each factor upon the other.

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For example, in the first unit on "Global Weather" we teach the child that smoke and other poisonous gases that pollute the air can change the weather by reducing solar radiation, thus causing temperature inversions. While this change then causes cooler than normal air temperatures near the ground, the cooler air then causes an even greater buildup of these gases, since the normal rise of air currents does not carry them away. It is important that the student see these relationships. But to demonstrate comprehension of the overall concept, he or she must be able to further relate individual human actions to consequences which alleviate or add to the original problem or, as is often the case, cause new problems.

As a case in point, discuss these following individual human actions in relation to the temperature inversion pollution phenomena:

1. A student insists on being driven by car to a nearby local recreation area, where he or she will exercise through some form of play or athletic activity. Or a student chooses to ride aimlessly around on his or her mini-bike, adding more exhaust pollution during such an inversion. Net result--a small, but negative, contribution to the air pollution problem. But that is not the end of it. The fuel wasted is also a part of a total resource system, fuel that could otherwise be used for a tractor to produce food or for an irrigation pump to provide precious water in drought areas where hunger and thirst threaten the lives of other children.

2. A student chooses to smoke cigarettes or other tobacco products, adding pollution not only to his or her lungs and bloodstream but to the air breathed by others as well. Net result -- a small, but negative, contribution to the air pollution problem, as well as to related lung cancer and heart disease problems. But that is not the end of this action either. Beyond the personal injury to health, the purchase of tobacco creates a demand factor for a nonnutritive crop. This crop displaces valuable agricultural acreage that could be used to grow food for the world's hungry children.

Pursue similar ideas with the students and ask for them to think of other such actions by individuals which, when <u>multiplied</u> many times by thousands and millions of other individuals, can have a life and death effect on other human beings and on our global environment itself.

For these reasons we have consciously designed this teacher's kit to help you teach children about their increasingly interdependent world through three separate but related units on different aspects of world environment. We are constantly evaluating the quality and impact of our educational programs, and we invite you to send us your comments and suggestions on this teacher's kit and any other of our materials you have used. Write to: Donald N. Morris, Director of School Services, U.S. Committee for UNICEF, 331 East 38th Street, New York, NY 10016.

(For further rationale and research on the teaching of global concepts to young children, see the teacher's guide to "Teaching About Interdependence in a Peaceful World," elementary teacher's kit #5419.)

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Footnotes:

1. Handbook of Environmental Education Strategies, Environmental Education Task Force of the New York State Education Department, 1977, p.1.

2. Ibid., p.1.

3. Ibid., pp. 2-10.

4. Piaget, Jean Paul. The Language and Thought of the Child (New York: Humanities Press, 1959), p. 191.

5. Moore, John W. and Elizabeth A. Moore, co-editors, "Connecting Everything to Everything Else," The Science Teacher, Vol. 43, No. 5 (May 1976), p.44.

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World Environment and the Child:
Global Weather Unit

Objectives: To demonstrate the interdependent effects of weather variations in one part of the world on the lives of people in other parts of the world;

To demonstrate how weather is affected by human activity (both accidental and purposeful) and how weather affects human activity all over the globe;

To show human responses -- the caring for children who are victims of disasters and the sharing of weather information for the benefit of all through the World Meteorological Organization.

Materials: Classroom world globe

Accompanying Worldwide Weather picture sheet

Copies of metropolitan newspapers listing weather conditions and forecasts for different parts of the world

Weather maps (obtained from area weather forecasting stations of local airports)

Radio or television set for weather news (Radio usually works best for more frequent weather news during school hours. In some cases the class may have access to a radio with special bands for more detailed weather information and forecasts.)

Poster paper and yellow, grey, blue, and white construction paper

Selected library books on weather and encyclopedia entries on weather and climate

Levels: Recommended for grades 3 - 8

Procedures:

Ask the class what comes to their minds when they think about weather. Might it be rain which keeps them from playing outside, cold temperatures which chill them through when the wind blows, or grey clouds which hide the warm sun?

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Whatever comes to their minds, they could know that weather is one of the things that affect each and every one of us every day of our life -- whether we think about it consciously or not. Ask them to look out the window and tell what they think the weather will be like today, tomorrow, and the day after. Ask how it will affect them if they are right and if they are wrong. Have them check a newspaper and a radio or television forecast against their own forecasts.

If possible, find a few copies of newspapers from past months reflecting seasonal variations, in addition to a three-or four-day sequence of copies that show the change in weather during the most recent week, Did these recent changes just happen or were they part of a moving system of weather from another part of the world? Ask the class if they have ever thought of how the weather systems that affect our country are linked with other systems all over the world.

Read the following quotation to the class:

> Without a doubt, weather tops the list as the most consistently interesting item in the news. This seems to be true in each nation throughout the world. People's interest in weather seems to stem from very practical concerns. Will it rain tomorrow? What will the temperature be? But even those simple interests in weather cannot be satisfied unless we have some way of collecting the useful knowledge which will allow us to make reasonable, accurate predictions as to what will happen.[1]

People have always been concerned about the weather in every climate* of the world. Have children look up climate in the encyclopedia to see how climate affects the lives of people around the world such as their clothing, food, housing, transportation, and the animal and plant life that surrounds them.[2] To help children understand the concept of climate discuss climate in the context of the following question: Do you live in a mild climate or does it get <u>very</u> hot some times of the year and <u>very</u> cold at other times?

World Weather History Briefs

The history of the concern and efforts of people to understand their climate and predict their weather has touched many parts of the world. In this period following our Bicentennial, Benjamin Franklin's name is associated with many areas of our history. Most children will readily recognize Franklin as the man who experimented with electricity by flying a kite in an electrical storm, but they may also be interested to know that from his studies he learned that storms move across the face of the earth in regular, predictable ways. As important as this knowledge was, it was not very valuable fro predicting weather in the latter 1700's. Ask the class if they can think of why this was so. At that time there were no telephones or telegraphs to use to send weather information ahead of the storms, and storms moved faster than the mail.

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* Climate -- the average weather in a particular area over a long period of time.

Explain that it was not until after the telegraph was invented and lines and cable began to link different parts of the world that very efficient weather forecasts could be made. Children should learn that weather scientists or meteorologists from all over the world studied the weather and ways to improve forecasting. They knew that they needed and depended on each other to help predict the weather in each of their own countries, i.e., they were interdependent.

As people in nations all over the world began to realize how much they depended on each other for accurate weather forecasts, they realized they needed a system that would collect information before big storms could form and come sweeping across their country, destroying crops, property, and often killing livestock and human beings caught out in the storms. Meteorologists in many countries of the world urged their governments to meet and plan a way to work together more closely for the benefit of all. Finally in 1873 many of the countries of the world came together to establish the International Meteorological Organization (referred to as the IMO). For many years the IMO helped countries in the exchange of information about weather, but there were still many things about weather that were unknown, particularly how to predict storms.

In the early 1900's two men from different parts of the world made some important discoveries about weather. A Norwegian meteorologist learned that different air masses had different properties. (Find Norway on your globe.) He also learned that at the places where two different air masses meet, weather conditions changed rapidly. He called these placed fronts. At about that time a British meteorologist discovered that mathematical principles could be used to help forecast weather. (Find Britain, i.e., United Kingdom, on your globe.) Both of these men studied and improved their ideas, shared them with other weathermen, and as a result helped to improve the lives of human beings.

By the 1930's and 1940's many more discoveries about weather were made as balloons and airplanes were developed that could go high into the sky. During World War II pilots flying at high altitudes found very strong winds there. (Ask the children if they have ever heard of the jet streams.)

In 1951 the International Meteorological Organization was reorganized. It became a special agency of the United Nations called the World Meteorological Organization (WMO) which is based in Geneva, Switzerland. (Find Switzerland on your globe.)

Then something happened in 1957 that would enable us to see our planet and great weather systems that were never seen before. (Ask children what they think that happening might have been.) Emphasize that 1957 was the beginning of the space age. The first satellite was put into orbit by the Russians that year. (Find Russia, i.e. the Soviet Union, on your globe.) Shortly thereafter, the U.S. launched the first satellite specifically disigned to collect and send worldwide weather information back to earth.

In the 1960's the U.S. and Russia sent many weather satellites into earth orbit and agreed to cooperate with each other to share their information. At the beginning of the 1960's, the United Nations General Assembly passed a resolution calling for the WMO to draw up a plan to insure that weather satellites and other such new devices would be fully used for the knowledge and benefit of all the peoples of the earth and that such knowledge would always be used in peaceful

ways. The WMO responded by setting up a new global system called the World Weather Watch in 1963. (Look in your encyclopedia to find out more about the World Weather Watch.)

Today we have satellites with television cameras in polar orbit around the earth that take weather pictures day and night of every part of this globe. These pictures can then be transmitted automatically to weather stations in every country of the world.

Worldwide Weather Viewed From Space

Show the class the enclosed picture sheet on Global Interdependence and Worldwide Weather. Look at the first complete view of the world's weather, put together in a mosaic mercator projection. Notice how cloud patterns showing weather systems join each other and lap over from continent to continent and out into the oceans. The many pictures used to show this first view of the world's weather were taken in 1965 by the weather satellite Tiros IX. How surprised Benjamin Franklin and other early scientists of the world would be! How proud they would be to know that by sharing their early discoveries, all the people of the world have benefitted from them.

Show the class the two more recent photos taken by the National Aeronautics and Space Administration's SMS-1 (Syncronous Meteorological Satellite). The picture on the left makes the earth appear much like a huge marble. (Hold the globe so the South America is facing the class as in this picture.) It was taken from about 22,000 miles out in space. To help children get a better idea of where SMS-1 satellite is in relation to the earth, ask them to place a string around the globe at the equator where it touches the coast of eastern South America (very near the mouth of the Amazon). The other end of the string when stretched out away from the globe will be about the same proportion of distance from the globe as the SMS-1 is from the earth.

Ask the class to look at the picture again. Call attention to the dry, cloudless sky above most of northern Africa on the far right. (Find the Sahara Desert on your classroom globe.) Then notice the swirling white clouds and the arrow at the upper left. Have students find the island of Cuba and the peninsula of Florida on the globe and then compare them with corresponding land forms in the picture. (The teacher may need to assist some children because the clouds covering much of the Gulf of Mexico make it difficult to see.) Notice the arrow is pointing to a mass of clouds. This is the tail end of Hurricane Carmen, an early September 1974 hurricane.

Note how the stream of cloud cover from that area spreads up the entire east coast of North America across the Atlantic Ocean just north of Spain and through France and on the far horizon connects with yet another storm system over northern Europe. Do you see how the air we pollute from the industrial areas in our east coast might be harmful to the people in Europe and beyond?

Read the following words to the class written by the editors of International Wildlife , from a special publication on global environmental quality:

> Air pollution knows no boundaries; poison in the air over Europe will later be poison in the air over Asia and North America...
>
> Neither is air pollution solely a big city problem. In the last 50 years, for instance, there has been a 70 percent increase in the amount of atmospheric dust measured at the resort area of Davos, Switzerland. And in remote Greenland, lead traces in the ice cap have increased 700 percent in the past two centuries.[3]

How much more believable and urgent these words become when we can see with our own eyes pictures of worldwide weather systems!

For a "close-up" of a major tropical storm, study the picture on the right showing Florida and Cuba clearly and the Yucatan Peninsula of Mexico at the left center just above the swirling cloud formation. That cloud formation is the fierce hurricane named Fifi, which you may remember struck the small country of Honduras on September 18, 1974. (Find Honduras on your globe.) Its fury was so great that it caused a rainfall of 30 inches in less than two days, breaking a world record. The flood waters were so powerful that they raged down from the mountains and valleys and swept away many houses, people, livestock, and crops. Can you see how people of the many countries in this part of the world need to depend on each other to report how powerful a storm is and the direction it is moving? If they have some warning, they can prepare for it and save many lives.

Too Much Water and Too Little Water

Look at the top left picture on the back side of the picture sheet. How does too much water affect the land and people? This photo was taken in northern Honduras three months after the hurricane. UNICEF immediately made available supplies to meet urgent food, health, and drinking water needs of children. In the months that followed, UNICEF and other agencies of the United Nations helped much more, as did government and volunteer groups from many countries.

Look at the picture in the top center. Such relief camps of tents were the homes of thousands of families uprooted by this weather extreme which the National Weather Service calls "the greatest storm on earth." Many families lost everything in the floods that were caused by hurricane Fifi. What might this Honduran mother be thinking as she looks at her sleeping boy?

In the right top picture, floodwater can be seen in the distance while children huddle under makeshift shelters. Their homes, like so many thousands of others, were washed away by the worst floods ever to hit Pakistan in 1973. Following this weather disaster UNICEF provided nearly a half million dollars worth of emergency food, drugs, vaccines, and water purification tablets.

Study the picture at left center. Here is an interesting contrast of land. Point out the large cracks in the shrinking dry ground showing that the weather at this season does not bring enough water. But look carefully at the vegetation in the background. During the rainy season this Southeast Asian field gets too much water. Compare the flooded fields and this seasonally dry field with the barren, dust-covered field of the African Sahel region pictured in the center.

Find the Sahara Desert again and then just along the south edge find the countries of Senegal, Mauritania, Mali, Upper Volta, Niger, and Chad. Much of the land of these countries and a belt east into Ethiopia have suffered a great drought for many years. Animals die, and little food can be found in this dry land. This picture shows a young African trying to get small scraps of meat from the bones of a dead animal. Recent rains have helped, but the problem is so great that it will be many years before the effects of the drought can be reversed. Try to find out if recent weather has brought rain or more drought to this region.

More UNICEF Responses to Weather Extremes

See the picture at right center. In drought areas and other places where children have little or no clean water, UNICEF supplies well drilling rigs to help. Here in Bolivia, where 90 percent of the children in rural areas become sick from drinking unsanitary water, such wells are greatly needed. The children pictured here will have a better chance to grow up strong and well, thanks to UNICEF and the millions of people all over the world who care and share.

Look at the small children in the picture at the lower left. This is a feeding center in Upper Volta where UNICEF has supplied protein-rich food such as CSM (a corn meal, soya flour and milk powder mixture) to help feed hungry children in the drought area.

Call attention to the picture at the lower right. Ask children what they think might be in the large bundles that look like cotton bales. When children's homes are destroyed by hurricanes, floods, or other disasters, UNICEF can ship blankets on short notice from its warehouse in Copenhagen, Denmark. These blankets are for children in Bangladesh. Many children from all over the world who share the same air, clouds, and sky have also shared by helping UNICEF provide such blankets. Ask the class if they know how they can help, too.

Using Weather News and Weather Maps

Look at the weather section of your newspaper. Try to find a weather report for a storm system in the New York metropolitan area and then see if there may be a similar storm system reported in London or Paris a few days later. (Major metropolitan papers usually have a dozen or more world cities listed. The New York Times lists over 60 cities.)

Bring a variety of weather maps for the class to study. These can usually be obtained from local weather forecasting stations or airports. If you live in the center of the U.S. or near the West Coast, try to trace a storm system from your area of the country east to New York, or from the Gulf of Mexico as in the case of the Hurricane Fifi picture. If you live in the East, try to chart what weather the prevailing westerly winds bring to your area. How are the winds and weather different at different times of the year?

The following simple activity can be done by younger children using weather news and their own observations to help them see a relationship between wind and weather.

Construct a large one-month weather calendar that can be placed on a bulletin board or a suitable wall space. The calendar should be large enough to allow for placement of wind direction and weather symbols in each space twice daily.

Using yellow construction paper have children cut out an ample supply of dime-sized sun symbols. They will also need a supply of paper clip-sized clouds cut from grey paper, a supply of slightly smaller tear-shaped rain drops from blue paper, and some small white snowflakes (preferably hexagonal). Precut letters, N-E-S-W, for wind direction symbols, may be used, or the letters can be marked on the calendar by crayon.

Each child can be the wind/weather recorder for one day, or this can become a project of an interested group of students. (With primary grades avoid adding complexities of wind velocity, weather temperature, and humidity.) The record should be kept daily, and observations made at the same time each morning and afternoon. Weekend weather can be recorded at home and the chart brought up to date on Mondays. Each daily square should have two letters reflecting morning and afternoon wind direction and two symbols for sunny-cloudy, rainy or snowy weather accordingly.

Encourage the class to agree to use the same source of information each day. A light piece of ribbon on an extended pole that can be observed from the classroom will achieve greater direct involvement by the class, and their observations can be compared with the local daily weather reporters. (Use of a radio with a weather band may be helpful.)

At the end of one month, make a chart with four columns, N-E-S-W. Have the class count the number of sunny. cloudy, rainy, or snowy half days that were matched with each wind direction. Tally marks may be used in each column, or children may prefer to actually place all the symbols from the calendar squares on the new chart under the corresponding wind direction column. Without using quantitative relationships at the primary level, the visual impact should be sufficient to indicate which wind direction seems to bring sunny, clear weather most often and which wind direction most often brings cloudy rainy or snowy weather. With older students the four columns could reflect ratios and percentages. (Examples: The wind blew from a generally western direction 10/30 or 1/3 of the month, and the weather was sunny 70 percent of that time.)

The hypotheses produced from this activity may be tested further by repeating the process during subsequent months of the school year. This may be particularly relevant at upper grades where more variables are added to allow for wind velocity, temperature, humidity, more specific wind direction (NE-SE-SW-NW) and combination symbols to reflect partly cloudy, light and heavy precipitation, as well as other pertinent weather observations of interest to the class.

Any such observations should help students at all levels understand that changes in weather do not just happen randomly but are dynamic environmental processes that move across the surface of the earth affecting all living things.

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This understanding is necessary to the achievement of the primary objective of all activities in this unit: to help students further develop the concept of global interdependence. Thus the implications of smog and other pollutants added to our wind and weather systems should be discussed more fully. How does such pollution added to the air in one place affect the environment and health of children in another part of the world? Can there be any effective solution to a global problem until governments all over the globe work together to solve it?

How Weather Affects and Is Affected by Us

To this point we have tried to emphasize the global interdependence of human beings in understanding and forecasting weather and in responding to each other's needs when weather disasters such as floods or droughts occur. Explain to the class that until a few years ago, no one thought seriously of the factor of interdependence between weather and human activity. The concept of interdependence can be further developed around this area.

Present the following problem to the class for thought and discussion. We all know we depend on the weather for rain for food crops and for fresh water lakes and streams. Ask the students to name more ways we are affected by the weather. Then ask if they think that human activities can really affect the weather. What might be some ways we affect weather in our world? Let the class discuss this further and give examples.

Herman Schneider, author of several interesting science books for children, looks into the future of "man'made" weather from his vantage point some 15 years ago as he writes:

> Perhaps, some day, we may know enough about the weather to make it behave as we want. Sunny days for play, rain for the farmer, snow in the country for sportsmen, calm winds for the sailor. Take your pick!
>
> However, man-made weather is still in the future.[4]

In the mid-1970's it seems part of that future has arrived. Read the following examples of headlines based on recent actual happenings:

SCIENTISTS TRY TAMING LIGHTING FOR APOLLO SPACE LAUNCH

U.S. -- SOVIET BAN ON WEATHER USE FOR WAR SEEN NEAR

WEATHER PACT TO OUTLAW CHANGES IN WORLD'S ENVIRONMENT FOR MILITARY PURPOSES

SOVIETS STUDY PLAN TO REVERSE RIVER FLOW IN ARCTIC

WMO CALLS CLIMATE MODIFICATION PLAN RISKY

WORLD FOOD -- WATER SUPPLY THREATENED BY WEATHER CHANGES

AIR POLLUTION THREATENS GLOBAL TEMPERATURE RISE

SPRAY CAN PROPELLANT FEARED HARMFUL TO OZONE LAYER

SKIN CANCER INCREASE FEARED IF OZONE LAYER DEPLETED

SCIENTIST CHARGES HURRICANE DETOURED

If current or recent headlines in your local or regional newspapers are available, include them.

Ask students to discuss each headline. What kind of news story is suggested by each? How might controlling lightning at Cape Canaveral affect the joint space projects of U.S. and Russian space scientists? How could the ability to control weather be used for military purposes against another country? In 1973 the U.S. Senate by a vote of 82 to 10 passed a resolution urging our government to seek an international agreement to ban weather control practices as weapons of war. Why might our government be so concerned about weather control? How could another country harm us by controlling our weather? How might a Soviet plan to reverse the flow of fresh warm water into the Arctic Ocean affect the temperature of that region? Did you know that temperatures and pressures at the polar regions affect the weather of the northern and southern hemispheres? (See entries under climate -- world climates in your encyclopedia.)

Explain the terms weather or climate modification. Ask students if they have heard of cloud seeding. This modern approach to rain making uses dry ice or other chemicals dropped through cloud formations from an airplane. Try to find stories of "rain makers." (See rain making in the encyclopedia.)

If human beings in one country could make it rain much more on their fields and crops, what might happen to the next country when the dry winds blow over it? If the first country took an unnaturally large share of the rain for its own food crops by rain-making methods, what might the second country do if its crops were wiped out by drought?

If weather and climate did change in parts of the world, how might it affect farming regions, forest areas, lakes and streams, deserts, or mountain snow and glacial systems? If weather and climate changed to make one country more productive and a neighboring country too dry to grow food, think how this might affect both. If the dry country started buying large quantities of food from its neighbor, might it not make food prices go up in both countries?

Did you know that large urban areas in almost every part of the world are creating pollution from increased energy consumption and that the release of heat in these areas has made them measurably warmer? Did you know that air conditioners used in many city areas to cool certain enclosed areas actually add to the heat problem by consuming and releasing more heat energy? How else do you think big city areas have an affect on weather? Cities consume many natural resources. Forests and wooded areas are often cut down. Grasslands and once cultivated land are paved over for streets, expressways, shopping centers,

parking lots, housing developments, airports, and industrial plants. On such land weather that once brought rains that were held in the soil now makes rains more likely to cause floods because it runs off too quickly.

Air Pollution and Weather

The air pollution around large cities tends to reduce the sunlight and solar radiation. This in turn causes changes in the circulation of the air which also affects the weather. Smog is an example of the interdependence of human activity and weather. Factories and power plants pollute the air with smoke and poisonous gases. These gases themselves usually do not harm people immediately when they are mixed in the open air. Sometimes they do irritate the throat and eyes. But combinations of gases and smoke may cut off the heating of air close to the ground by reducing solar radiation. This can cause a temperature inversion, a layer of cooler air near the ground with warmer air above it. In such cases the air near the ground does not rise and carry away poisonous gases.

Read the following examples of headlines based on real events in world weather history:

TWENTY DIE -- THOUSANDS ILL IN PENNSYLVANIA KILLER CLOUD

KILLER SMOG CLAIMS 4000 IN LONDON

AIRPORTS CLOSE -- THOUSANDS ILL IN CHICAGO SMOG

SAN FRANCISCO POSTS SMOG ALERT

400 DIE IN NEW YORK SMOG -- THOUSANDS FLEE CITY

LOS ANGELES SMOG CLOSES CITY PLAYGROUNDS -- PARENTS ASKED TO KEEP CHILDREN INDOORS

TRAFFIC POLICEMEN WEAR GAS MASKS IN TOKYO STREETS

Ask children to imagine what kind of story might be behind such headlines. As an exercise relating science and social studies to language arts, ask interested students to imagine they are writing a short newspaper story for one of these headlines. (See the bibliography for a book, Wide World Weather, which has a special chapter on air pollution and weather.)

If you have a major metropolitan newspaper, you may find that along with the weather forecast it will also tell you about the quality of the air and warn you if it is "unacceptable." Radio and television forecasts often give information on the condition of the air. Try to find a forecast that will tell you about pollution and pollen in the air as well as the temperature, humidity, and wind conditions.

As a real example of how interdependent all countries are for their weather forecasting and information exchange, explain to the class that mainland China (People's Republic of China) did not belong to the United Nations or the World

Meteorological Organization for many years. But it was so important to China, as well as to the other countries, to exchange information that the Chinese government radio stations "unofficially" broadcast weather reports on various parts of that huge country at a specified time each day. The Japanese government radio stations monitored their broadcasts and passed the information on to the WMO in Switzerland along with their own reports. China in turn monitored the Japanese radio broadcasts and those of other surrounding countries which had powerful transmissions of weather information. Everyone gained from the exchange of information even though their governments were not ready to recognize each other officially for political reasons.

Weather Unit Summary

Again ask the class what comes to their minds when they think about weather. This time their answers should include how weather affects the lives of people in all parts of the world and how people respond to and affect the world's weather. Ask the class to list ways in which weather affects human beings and another list of ways in which human beings affect the weather.

Children can begin to see what interdependence really means when we provide them with real-life examples of such interdependencies in both natural environmental systems and in cooperative systems set up by human beings, such as the World Meteorological Organization and the World Weather Watch.

To further challenge their thinking, at the close of this unit ask them to imagine a world in which meteorologists could guarantee long-range forecasts accurate to within a fraction of a degree of temperature and to a thousandth of an inch of rainfall. Then imagine how the World Meteorological Organization could use such information working with the Food and Agricultural Organization, UNICEF, and other such agencies to plan for the most beneficial uses of weather for food production and to avert loss of life and property from weather extremes. Finally, ask them to imagine a world in which weather scientists could control all weather. Would we be more or less interdependent? Would it be more or less important to have peaceful cooperation in such a world? Are such things possible in the future?

* * * * * * *

Footnotes:

[1] Navarra, John Gabriel. Wide World Weather (Garden City, N.Y.: Doubleday & Company, Inc., 1968), p.18.

[2] World Book Encyclopedia, 1975, p. 520.

[3] "Air," World EQ Index, 1974, p.11. A magazine produced by the editors of International Wildlife magazine and published by the National Wildlife Federation (Washington, D.C.).

[4] Schneider, Herman. Everyday Weather and How It Works (New York: Whittlesey House, 1961), p. 132.

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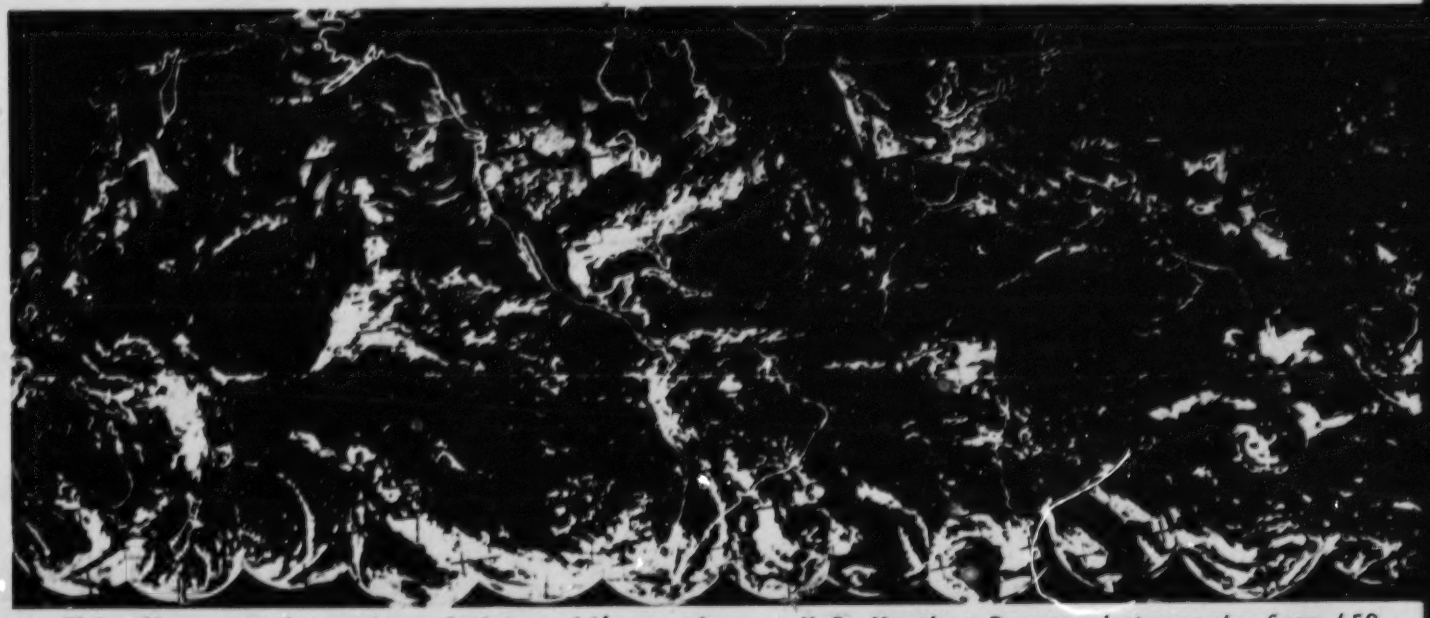
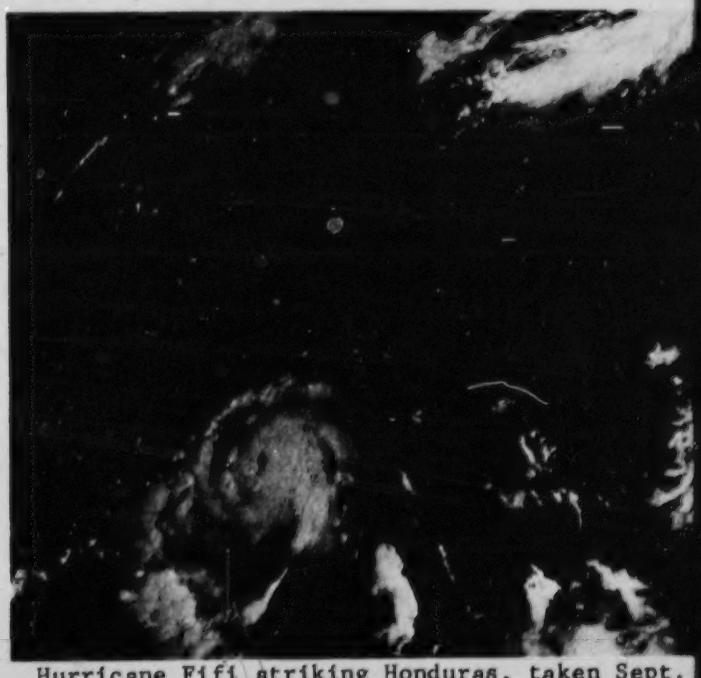
GLOBAL INTERDEPENDENCE AND WORLDWIDE WEATHER

World food supplies and prices have long depended on the weather. Today we are becoming more interdependent. Human activity changes weather, accidentally as in pollution and purposefully as in "rain making." The same world weather systems that bring cool fresh breezes from one place become intercontinental carriers of pollution to another. These same world weather systems that gently water crops in one place wash away soil and crops in another, and their dry winds move on to steal what precious moisture remains in the neighboring drought areas. Truly we are interdependent with weather and with each other.



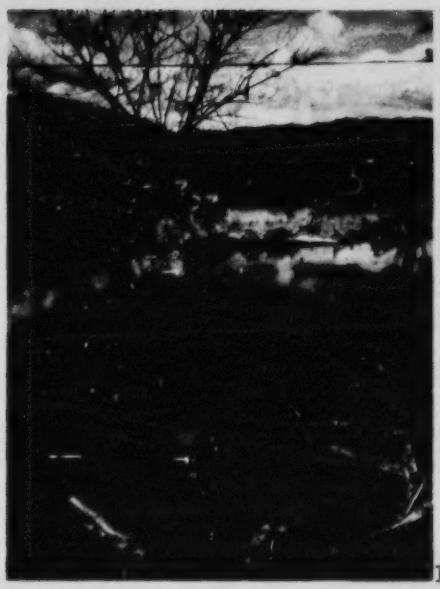
This first complete view of the world's weather, a U.S. Weather Bureau photomosaic from 450 pictures was taken by Tiros IX on February 13, 1965. Can you find each of the continents?

A hemisphere of interrelated weather systems showing hurricane Carmen (arrow), taken by NASA's Synchronous Meteorological Satellite 1.



Hurricane Fifi striking Honduras, taken Sept. 18,1974 by SMS-1. Note how this storm bridges the two continents as well as the two oceans.

Photos by the National Aeronautics and Space Administration



ICEF 6992/Liftin

ICEF 6767

Too much water and its effects on the land and people.

ICEF 6982/Liftin

ICEF 6876/Danois

ICEF 6918/Davico

Too little water and its effects on the land and people.

ICEF 6645/Mangurian

ICEF 6884/Diabate

ICEF 6506/Ockwell

At such times people depend more on each other -- and that's what UNICEF is all about.

WORLD ENVIRONMENT -- OUR RESTLESS EARTH

Objectives: To develop global perspectives by studying this unit and the accompanying photos showing the earth from space and areas that have been changed by movement below the surface of our restless earth (tectonic activity);

To use simplified earth tectonics to help elementary and junior high students understand the interrelatedness of all the earth's crust on which we live;

To show human responses -- the caring for victims of earthquakes and related disasters -- and the way people all over the world depend on each other, i.e, global interdependence

Materials: Classroom world globe

Accompanying pictorial wallsheet "Our Restless Earth"

Soft modeling clay, silly putty or playdough and two small pieces of stiff corrugated paperboard approximately 4" x 6"

Science equipment stand or similar stand, card table, or other lightweight table, spiral spring with hooks such as ironing board cover spring fastener and a paperweight or similar small heavy object.

Paperweight or other heavy object tied to at least four feet of string

Two small pieces of plywood (approximately 18" x 24")

Two yardsticks or other long flat sticks

Eight or ten pounds of sand (best when mixed with gravel and some natural clay or soil)

Small shallow lightweight plastic or metal pan

Miniature models of buildings, homes, cars, trucks or small blocks or paper constructed items which can represent a small-scale human settlement (village, or a portion of a town or city)

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A selection of children's books with information and diagrams on earthquakes, and encyclopedia entries on earthquakes

Levels: Recommended for grades 3 through 9. (Some components such as the "Make your own earthquakes" and the picture sheets can be used with younger children when read and explained by the teacher.)

Procedures:

Ask the students if they have ever experienced an earthquake or if they know of anyone who has been in an earthquake. What might it feel like to have the ground move beneath your feet, see hanging lamps swing from the ceiling, or see furniture move across the floor? What might it be like to see large buildings come tumbling down around you and to see the earth heave and streets twist before your eyes?

They may be surprised to learn that "earthquakes" occur almost everywhere in the world, and there are hundreds of thousands (some sources say millions) of them each year. However, it should be explained that a large number of these are more accurately referred to as earth tremors or shocks, and that most of these small earthquakes are too weak to be noticed except by earth scientists using sensitive instruments.

Nevertheless, there about 20 major earthquakes a year capable of producing widespread destruction and death to many people. Because many of these occur beneath the sea or in remote land areas away from human settlements, they are of less immediate concern.

Those most severe and most widely destructive earthquakes, referred to as great earthquakes, occur on an average of one every two or three years. One of the most destructive of these earthquakes has recently struck Guatemala, our neighbor to the south, in early 1976. (Refer to the wallsheet.)

But before further discussing any particular earthquake, the teacher should help students gain some basic understandings about earthquakes and tectonic activity. And to understand these, students should first learn something about the inside of our restless earth.

It may be helpful to draw a simple diagram such as Figure 1 on the chalkboard or on a large sheet of newsprint. Some students may wish to make a display model from colored construction paper. (Suggest the crust be brown, the mantle orange, and the core bright red. A thin layer of blue ocean could cover three-fourths of the crust.) Upper grade students might want to do further research into the differences in the likely make-up and temperature of the various layers inside the earth. However, the important concept at this point is that the earth's crust is a very thin layer of rock easily broken by the force of movements in the hot, pliable mantle below it. For younger children explain that the earth's crust might be compared to the crust on a loaf of bread, thinner in some places than in others, with harder and softer spots here and there and with some cracks in the crust.

More recent findings by earth scientists have supported the theory that plates or large sections of the earth's crust have been broken apart by tectonic activity or movements and changes where the upper mantle meets the crust. Although the analogy certainly has limitations in its validity, it maybe useful for children to picture the hot dough and gases expanding as the bread is baked, causing cracks in the crust as being comparable to the hot mantle moving up through the earth's crust as in the formation of the Mid-Atlantic Ridge in the Atlantic Ocean. It is then the movement or collisions of these large continental or ocean area plates that cause most of the earthquake activity. Such plate tectonic movement has more commonly been called continental drift.

Although the term continental drift may be easier for younger students to conceptualize, it may be helpful for them to think of the continents as those surfaces of the plates that are not covered with ocean water and the plates as large sheets of the earth's crust (ocean floor and dry land) that float on the hot, plastic rock mantle of the earth.

But first let us concentrate on the great single land mass that scientists believe was once made up of all the continents together. Figure 2 shows an outline of the jigsaw puzzle-like figure which the scientists call Pangaea (from the Greek words pan meaning all and gaea meaning land.)

Very, very long ago as we think of time, about 150 million years ago, the Pangaea crust of the earth was broken into two huge super continents. (This was not long ago compared to the age of the earth, which scientists place at four or five billion years.) These two new land masses were called Laurasia and Gondwanaland. Figure 3 shows what scientists believe they looked like.

During the next 100 million years after that, Laurasia and Gondwanaland were broken into about 20 separate sections or plates. Some were shaped very much like some of our continents today. Others were partly covered by oceans. Still other plates were made up entirely of ocean floors. Some of these plates moved short distances. Others moved very long distances. (Refer to the wallsheet of photos taken from space and high altitude aircraft and satellites.)

As these plates moved, scientists believe they caused earthquakes basically in three ways. Where they moved away from each other, new material from the earth's mantle was forced upward, forming rough ridges between the plates. These ridges, such as the Mid-Atlantic Ridge and the Mid-Indian Ridge, can be seen on some of the maps and globes you may have in your classroom.

Often other more violent earthquakes were caused by plates moving toward each other and colliding with great force. In the case of the South American plate, it moved westward and collided with an eastward moving plate covered by part of the Pacific Ocean. This is believed to have caused a deep trench where the ocean plate was forced downward and also to have caused the formation of the Andes Mountains, for great pressure caused a buckling and folding of the western edge of the South American plate.

Scientists also believe the evidence is very strong that the Indian plate carried the Indian subcontinent northward at such a force that it collided with Asia many millions of years ago forming the Himalayan and connecting mountain

systems. Earthquake activity in these areas is still being caused as recently as 1974 and 1976 from the great strain and pressure on the rocks in these mountainous areas. (Refer to the wallsheet "Our Restless Earth" and the composite picture which shows strong evidence of such a great collision.)

The third kind of plate movement that causes earthquakes may best be illustrated by the movement of plates in opposite directions along the edges touching each other. The earthquakes along the San Andreas fault in California may serve as excellent examples of this kind of plate activity. (See Figure 6 and refer to the wallsheet again.)

Figures 4, 5, and 6 can be sketched on the board or laid out with colored construction paper on a bulletin board. (Use blue for oceans, brown for plates, and orange for mantle.)

The tectonic activity in Figures 4 and 5 can also be demonstrated more concretely for young children with two small pieces of fairly stiff corrugated paperboard (large enough to handle in order to crumple under pressure, approximately 4" x 6" or so.) Place them next to each other on a similar sized, not too thin, sheet of soft playdough or suitably moist pliable modeling clay. Slide paperboard pieces apart slightly and press down with pressure on parted edges, until clay or playdough oozes up between separation. This represents ridge formation as in Figure 4.

If the paperboard is very stiff, score one piece lightly along two or three corrugations on one edge. Then place two edges of the corrugated paperboard together, making certain the corrugations are all parallel to the line where two pieces join. Have students help hold the adjoining edges down while the teacher forces the two pieces together. The scored piece should buckle and rise on the edge while the other stiffer piece presses against the buckling edge and turns down into the clay under the other piece. This represents parallel mountain range formation like the Andes and the Himalayas.

Once students have some basic understanding of what causes most earthquake activity, there is a need to develop empathy by focusing on their potential involvement in quakes in the U.S. Most children in the U.S. have never experienced a destructive earthquake. Many have the idea that this is something that happens only in foreign countries. To help children develop a better understanding of the earthquake as something that can affect us all, the following section, "Major Earthquakes in the U.S.," can be read to the class and discussed as a whole or given to individual students or groups to read on their own. The same procedure may be used with the other two student material sections "Measuring Earthquakes" and "Make Your Own Earthquakes." Permission to reproduce copies for class use is hereby given. For use with lower grades, the teacher may read and discuss the material with the class.

MAJOR EARTHQUAKES IN THE U.S.

One of the most famous earthquakes in the U.S. was the San Francisco earthquake in 1906. It was along time ago, but some people who are still living remember it. The stories they tell are very interesting.

It was just after 5:00 o'clock in the morning on April 18, 1906. Most people were still in their beds asleep. But the milkmen, farmers bringing fruit and vegetables to market, the policemen, and others who work very early in the morning all told stories that seemed unbelievable. Brick streets started to rise and fall in ripples and waves like an ocean. The heavy steel trolley car tracks were suddenly twisted into "S" curves and buildings began to creak and fall down. Electric power lines broke loose from their poles and flashed bright blue sparks, starting fires. Other fires were started by cooking stoves that were knocked over by the quake.

The earthquake was over in a little more than one minute, but the fires that were started got bigger and bigger. The firemen connected their hoses to the fire hydrants. But they could get no water. Can you guess why?

The earth's crust had moved not only up and down. It had split apart along a line called a fault and the part on one side of that line moved several feet to the north. This caused all of the water mains and water pipes under the ground to break. Without water firemen could not stop the small fires. Most buildings were built at least partly out of wood. They burned easily, and the fire spread throughout the city. When it was over, 28,000 buildings had burned. This did not include the many buildings shaken down by the earthquake. Over 600 people had been killed, and many tens of thousands were made homeless.

Later people learned that the earthquake that did all of this damage was not just a San Francisco city earthquake. It was an earthquake that shifted land along a line in the earth almost 250 miles long. This line of breaks in the earth's crust is called a faultline. The name of that particular fault is the San Andreas fault. You may have heard about it. Most people who live in California know about it. Many are concerned about the San Andreas fault because it is still an active fault. Look at the picture of the Los Angeles area on the wallsheet "Our Restless Earth." You can see a section of the San Andreas fault there.

But California is not the only place inthe U.S. that has earthquakes. We usually expect earthquakes to be found in mountainous areas near oceans or other deep bodies of water. We would least expect a violent earthquake in a flat low area near the middle of a continent. However, you may be surprised to learn that one of the strongest earthquakes in the earth's history happened right in the middle of our country, in Missouri.

Of course in 1811 Missouri was not yet a state. It was a part of the Louisiana Purchase. The U.S. bought it from Napoleon (the ruler of France) just eight years earlier. Not many people lived there then, except Indians, traders, and a few farmers.

On a cold December night when everyone was asleep, they were awakened by the sound of logs in the walls of their cabins twisting and groaning. The stone chimneys fell first, but many of the flexible log cabins stood during the first of the quakes. As the second strong quake struck, even these flexible cabins tumbled down.

From the descriptions of what happened, scientists know that it was a very strong earthquake even though few people were injured. Why do you think this could be true? (Remember there were no tall buildings and no steep mountains in the area.)

People know how powerful this earthquake must have been because of the changes in the earth near there. It caused a large mass of land -- almost 30,000 square miles -- to sink between five and 15 feet into the earth. Just across the Mississippi River in western Tennessee, an area of 12,800 acres sank so low that it made a lake called Reelfoot Lake. It is still there today as evidence of this powerful earthquake.

John James Audobon, the famous naturalist you may already know about, was many miles away in Kentucky at that time. He was riding his horse when the second quake struck. He later described how the ground waved like a field of corn in a breeze. Other people as far north as Canada, as far south as New Orleans, and as far east as Boston felt the first two big shocks.

A church bell in Charleston, South Carolina, began to ring in the middle of the night. People could not understand why. They went to the church and found no one was ringing the bell. How do you think they might have explained it? What would you think if you had been there? Later they learned about the earthquake many hundreds of miles away.

One of the strongest earthquakes in the United States happened just a few years before you were born. Your parents can tell you about it, and you can find many pictures in books and magazines in your libraries. It was the great disaster called the Good Friday Earthquake.

It was late afternoon, March 24, 1964. Families were shopping in the stores at Anchorage (the largest city in Alaska.) They were buying the things you and your family buy just before Easter -- fresh eggs, dye for coloring them, chocolate rabbits, Easter baskets, and other treats for the holiday weekend. Suddenly there was a deep rumble like the sound of thunder. Large chunks of the streets and sidewalks started to tremble. In many places they crumbled and sank 30 feet into great holes or cracks in the earth. Within three to five minutes 115 people died and 4500 were left homeless. The damage to property was very, very great. Think for a moment. The U.S. bought Alaska from Russia about 100 years before for $7,200,000. The property damage from this earthquake was more than 100 times more costly -- $750,000,000. Scientists later reported that over one million square miles of land and ocean floor had been affected by this great earthquake. Can you picture in your mind how strong such movements in the earth's crust must be?

Just saying how costly an earthquake is or how much land or ocean floor it shook is not enough. How can we accurately compare the force of one earthquake with another Earth scientists call seismologists have learned to measure earthquakes. How do you think this might be done? If you want to know more about this, ask for the mini-unit on "Measuring Earthquakes."

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MEASURING EARTHQUAKES

There have been little earth tremors and great earthquakes all over the earth as long as there have been people on this earth (actually much longer). People were always curious about them. Some believed the earth was a flat surface on the back of a giant turtle. When the turtle moved a little, we had a little tremor. When the turtle rose up quickly or took large steps, we had a great earthquake. Stories from other cultures long ago told how the earth was held up by elephants, and earthquakes were greater when the elephants moved more. You may want to find other interesting stories about what different things caused earth tremors and quakes.

No one knows for sure who first measured an earthquake. But about 2000 years ago, a man in China built a simple seismograph, an instrument to measure movements of the earth's crust. You can read more about it in an interesting book recommended for grades five and up (Historical Catastrophes: Earthquakes by Brown & Brown, Addison-Wesley, 1974, p. 52). The principle used in all the early seismographs was the principle of the pendulum. Any heavy object attached to the end of a light stick, string, or spring can be a pendulum. A pendulum tends to stand still when it is not moving, even if things around it begin to move suddenly. It also tends to continue moving in the same direction when it is moving. And it tends to continue moving at the same speed.

You have probably seen pendulums in old clocks. Usually you think of a pendulum as something that moves while a clock stands still. A pendulum in a seismograph is just the opposite. It stands still. When the earth quakes or shakes, all of the seismograph except the pendulum moves with the earth. This is why the striker or clapper in a large church bell could clang during an earthquake. The church and the bell tower moves and strikes it.

To demonstrate this, take a long string about as long as you are tall. Tie one end to a weight such as a paperweight. Then hold the other end up just above your head. With the weight just off the floor, move your hand back and forth very rapidly. Stop quickly. Notice the weight did not move very much. It tended to stay still. (This is sometimes called inertia, at rest.)

If you can make or find a stand that will fit on a card table or other similar table that will wobble slightly, try this experiment. Find a small heavy weight and a light spring. An ironing board cover spring-type holder or a spiral notebook wire or similar spring will do if your weight is not too heavy. Hang the weight from the stand by the wire spring.

Then carefully lift one corner of the table quickly and set it down, jolting it to one side. Watch the weight move. It is the first movement that is important. Think! When the table goes up and down and to one side the weight tends to stand still. If you had a pen attached to the weight and touching a paper surface attached to the stand and table, it would make a wavy line on the paper. In this way you could measure how much the table and stand moved.

This experiment is very simple. Real seismographs are much more complicated. But similar pendulums attached to pens that drew lines on moving pieces of paper have been used for 100 years. Some seismograph pendulums weight more than 20 tons. Other modern seismographs use beams of electric light which show movements on photographic paper. Some measure electric current made by the earth shaking heavy steel magnets. Some modern seismographs are so sensitive that they can measure the vibrations made by a spider crawling across it. However, when an earthquake is measured, we must have some way to describe it or report how strong it was.

There are two different scales, or measures, used to describe and report earthquakes. One is the Mercalli Scale which runs from I to XII. Note that this scale is always written in Roman numberals. It is more correctly called the Modified Mercalli Scale since it was modified or changed to include modern structures that did not exist in 1902 when Mercalli, an Italian seismologist, first invented it. It is used to report personal observations -- what people feel and see themselves.

The twelve parts of this scale measure intensity and are as follows:

I. A shock recorded by seismographs only. Not noticed by people, although they may feel dizzy or nauseated. Sometimes birds and other animals seem uneasy.

II. A shock felt indoors by a few people, especially if they are on the higher floors of a tall building. Hanging objects and tree limbs may sway.

III. This shock is felt by a number of people on lower as well as upper levels of buildings. Automobiles that are standing still may rock slightly.

IV. Many people indoors feel this shock, and a few who are outside. Doors, windows, and dishes may rattle.

V. Almost everyone indoors, even those who were sleeping, may feel this one. Pictures may fall off walls, bells in churches may ring, and furniture may shift slightly.

VI. Everyone, indoors and outdoors, will feel this one. Poorly constructed buildings may be damaged. Furniture may overturn. Windows may break.

VII. People are frightened and run outside. They find it difficult to stand. Drivers of automobiles cannot control the movement of their cars. Well-constructed buildings are not damaged, but ordinary buildings suffer some damage. Bricks and stones are dislodged.

VIII. Most chimneys fall. People are alarmed and may panic. Trees shake with some breaking off. Damage to well-constructed buildings is slight; ordinary buildings may collapse.

IX. Total destruction of a few buildings. People are generally panic-stricken. There are cracks in the ground. Underground pipes sometimes break.

X. Ground cracks may be several inches wide. Well-built wooden buildings and bridges are badly damaged. Cement and asphalt roads may develop open cracks.

XI. Stone buildings are destroyed. Bridges fall, and railway lines are twisted. Pipes buried in the earth are all broken.

XII. Damage is complete. All manmade structures are destroyed. There are great changes in the surface of the earth.

The second scale, or measure of earthquakes, is the Richter Scale. It is more difficult to understand. It is expressed in two ways, magnitude and amplitude. Magnitude is the measure of actual energy released. Amplitude is the measure of the strength of the seismic waves produced by the earthquake.

On the Richter Scale each number step higher measures ten times greater amplitude but 60 times greater magnitude. For example, an earthquake measuring 5.0 on the Richter Scale is ten times greater in the seismic waves recorded than one measuring 4.0 on the Richter Scale. But that same earthquake is actually releasing 60 times as much energy. If this is not easy to understand, do not be too concerned. You may want to read more on this in some of the books listed in the bibliography.

However, it may be easier to understand the Richter Scale by comparing it to the modified Mercalli Scale in the following way.*

Non-Scaled Popular Terms	Richter Scale (Magnitude)	Modified Mercalli Scale (Intensity)
usually "unnoticed"	less than 3.0	I
usually "smallest felt"	3.0	II-III
"small"	4.0	IV-V
"local damage"	5.0	VI-VII
"moderate" considerable damage	6.0	VII-VIII
"major"	7.0	IX-X
"great"	8.0 or more	XI-XII

* This comparison can be helpful in learning about how magnitudes relate to intensity, but it should be noted that these are approximate relationships only.

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Another way to compare the magnitude of the energy released in an earthquake is to compare it to an explosive force of TNT. A 5.0 Richter Scale quake is equal to about 20,000 tons of TNT explosives in energy released. (The first atomic bomb exploded in 1945 was equal to 20,000 tons of TNT.)

The next time you hear of an earthquake in the news, find out what number and scale are reported. Then try to compare it with other earthquakes you have read about. You may also want to compare their force with an equal amount of TNT explosive force.

Now that you know something about how to describe and measure earthquakes, you might like to make your own earthquake. After you make your model earthquake, you may want to study it carefully and describe it by the I-XII modified Mercalli system. You cannot measure a model quake by Richter scale, but you can make a good guess or an estimate by using the number table above. Ask your teacher for the "Make Your Own Earthquakes" mini-unit.

MAKE YOUR OWN "EARTHQUAKES"
SIMULATION/ROLE PLAYING ACTIVITY

Do you think there could be an earthquake where you live? Earthquakes can happen anywhere in the world. They can happen in low, flat land. They can happen under the sea. They can happen in the mountains and often do. Earthquakes usually do more damage in the mountains than on the plains or under the sea. Why might this be? You and your class or small group can do some simple experiments to help you find out why.

You can make a model of a small village (or a part of a larger community). You may also want to pretend that each of you lives in a different part of the model village or area to make it seem more real. Choose a few of your group or class to pretend they are leaders or persons of some responsibility in the village. For example, one could be the village chief or mayor, another a priest or other religious leader. Others could pretend they are a doctor, a school teacher, or a storekeeper. Each one could tell what he or she would do first.

It may also be interesting to act out the parts of the various survivors. (Remember, if your house or part of the village is covered by a landslide, you would not be one of the survivors.) Each one could tell about what happened in his or her area. Think of other persons who might come to the area after the quake. (UNICEF officials, government leaders, scientists, etc.) Why might people from other parts of the world be concerned about earthquakes in far away places?

Simple steps to make your own earthquake:

1). Find a piece of plywood or other sturdy, flat board to work on. (You could use a small work table or desk top if covered with a heavy plastic to protect it.)

2). Place two yardsticks (or similar flat sticks) on the board.

3). Attach one end of each of the sticks together loosely with string or rubber bands.

4). Cover the attached ends of the sticks and the center of the board with a bucket of moist sand mixed with a small amount of gravel and earth.

5). Use your hands to form a valley with a mountain on each side.

6). Make some flat ledges or terraces on the mountainsides and on one mountain make some tall peaks.

7). Place some buildings in the valley to form a village or town area. Also place some small houses or other buildings at the bottom of the mountain and others on the flat ledges under the tall peaks. (You

can make your own from construction paper or use pieces of games such as Monopoly houses and hotels.)

8). Make some little roads with bridges and some paths leading from the village or town area up to the ledges under the peaks.

9). You may want to add small sticks and twigs for trees, toothpicks and thread for utility poles and lines, and other such material to make your model look more real.

10). When you have a completed your mountain area model, write down on a piece of paper:

A. How many people live in the village or area;
B. Where there is a school, marketplace, or other place where many people would gather together;
C. Which places people are most likely to be at different times of the day night.

Before you start the earthquakes, choose one person in your group to look at the second hand on a watch or clock. Use the position of the second hand to represent the hour when the earthquake strikes. For example, let each five seconds (the space between any two numbers on the watch or clock face) stand for one hour. Each time there is a quake, write down about what hour the second hand was pointing to. (You will need to let the second hand go around twice each time to represent 24 hours in the day.)

Now you are ready to make an earthquake. Earthquakes are powerful, but the real earth is very heavy and packed more tightly than your model. So start very gently. Move the two free ends of the yardsticks apart a very small amount. Then tap lightly on the edge of the board. Watch carefully to see what happens. Earthquakes often have many small shakes or tremors before the main or strongest quake. Look for cracks in the earth and small pieces tumbling down from the peaks onto the ledges.

Write down which houses or buildings are affected first. Then move the yardsticks just a bit more, and tap a little bit harder on the edge of the board. Stop to record what has happened each time and at about what hours of the day or night it was. Are roads covered? Do bridges fall in? Are telephone and power lines damaged? Remember, you have built a small-scale model. Any small cracks or small tumbling down of material represents a large movement in a real earthquake.

After your earthquake, count how many houses and buildings were covered. The people in these places should be counted as missing or killed by the quake. How many houses or buildings had some material or pieces of gravel fall on them? Try to decide how many people would probably be killed and injured there. Remember to check the time of day when each house or building was struck.

When you have completed your casualty report of the number killed, missing, or injured, try to decide what other damage was probably done. What about roads, railroads, bridges, utility lines (if there were any), fires started during the

quakes, wells covered or caved in, food crops destroyed in the fields, or food storage areas covered by landslides? What other kinds of damage can you think of? How is the environment changed?

Discuss these things with your group or your class. Then try to decide what things you should do first if you were in charge of giving aid to this area after an earthquake. What kinds of help do you think would be most needed by children your age in such an earthquake? Find out the kinds of aid UNICEF provides for them.

Do you think the damage done by earthquakes in distant places affects you in any way? Think of the many things you and your family buy and use that come from other countries. In a world where food is already scarce and high priced, what might happen in your food stores if food crops far away are destroyed by disasters such as earthquakes, hurricanes, and droughts?

(Optional Activity)

You may want to make another model of a flat plains area with a body of water on one side of the model. Find another flat board or use the same board if you are finished with the mountain model. Repeat the process without building any steep areas. Place a tray or shallow pan of water filled near the brim on one end of your board. Again be careful to observe what happens when the board is firmly tapped on the top or the bottom and on the side. Move the yardsticks under the sand again. Remember, each <u>small</u> movement on a model represents a <u>big</u> movement on the earth. Compare the results of your earthquake in the mountain areas with your earthquake on the flat areas and on a body of water. Even though water is not solid and does not "break up" in earthquakes, you might want to look up <u>tsunamis</u> in a book or encyclopedia. They are big waves made by earthquakes which can be very destructive.

* * * * * * * *

Now you are ready to compare your earthquakes with some real earthquakes that have happened in recent years. Ask your teacher for more information on this. Also look in your library for books on earthquakes as well as in your encyclopedias and in science and news magazines.

TO THE TEACHER

This section of the unit has been designed to use last. It is directed primarily to the third objective -- relating human responses to natural disasters which radically change the environment of the child. Through the use of the other sections of this unit (on basic earth tectonics, earthquakes in the U.S., measuring earthquakes, and student activities in making model earthquakes), we have tried to develop a basis for a better scientific understanding of earthquakes while at the same time building a foundation for empathic understanding. But students need to become more sensitive to the human and personal dimensions and to realize that every one of us is a potential victim of natural disasters such as earthquakes. The descriptions of earthquake disasters and follow-up programs of disaster relief and assistance should be presented as examples of human interdependence -- people depending on each other. The apparent simplicity of the idea of the "rich, unaffected" nations giving to the "poor, disaster-stricken" nations may seem to imply dependence. However, as was presented in the guide to the teacher's kit, all things in this world are linked to each other. The overriding imprint of interdependence can be seen in all natural and human relationships. (Refer to teacher's guide for amplification of this concept.)

* * * * * * * * *

Alfredo Juixan was sound asleep. Tuesday, February 3, 1976, had been a long day. The day starts early for most boys in Guatemala. There are many quehaceres or chores to be done, and every hour of daylight is needed. Many Indian families are so poor that they must work nearly all their waking hours. The law requires children between seven and 14 to go to school. But only after they have tended their small crops and few animals can many boys be spared the time to go to school.

Suddenly Alfredo was awakened by a deep rumble in the ground beneath him. He was used to getting up at daybreak, but it was three o'clock in the morning. The rumble sent a chill through him, worse than the chill of the February night air. Sometimes it gets near freezing in the mountain valleys of Guatemala. Alfredo and his family were among the lucky ones. They awoke and rushed out into the chilly night air into the streets of Tecpan, Guatemala. They escaped before the stones and adobe bricks of their small house came tumbling down on them. But many of their neighbors were not so fortunate. Tecpan, a town of 12,000 people about 33 miles to the west and a bit north of Guatemala City, was destroyed in 30 seconds. And most of what was left standing after the main quake came tumbling down in the aftershocks that started a half hour later and continued for several weeks.

But this was not the end. Alfredo was brave. He and his family had faced hardship before. He was only ten years old, but he was ready to work to rebuild his home. The picture on the wallsheet shows ten-year-old Alfredo reading while he sits guarding the family homesite. His family is busy searching for food. How do you think Alfredo feels? What would you do if you were in Alfredo's place? What other kinds of needs do you think Alfredo would have? (Although the climate is warmer than ours, remember it is winter and the dry season. It seldom rains in February in that area. The stores and business places have also been destroyed.)

Alfredo had felt the earth move and shake before, but never with such force. He did not know that a major earthquake, 7.5. on the Richter Scale, had struck all across his country. As terrible as it was in his town of Texpan, it was even worse in the towns to the north and east. In an area several miles wide and nearly 150 miles long, 22,000 people were killed, 75,000 were injured, and more than one million were made homeless. To be homeless any time is bad. But to be homeless in the winter, to be without food and water, and to be injured without medicine and bandages is even more terrible. As many as 500,000 children like Alfredo and the boy with the bandage on his injured head had no place to escape the cold. (See picture on wall-sheet.) The injured had no hospital and the few lucky ones who were bandaged and treated had to stay in hospital beds set up in the streets.

But the children of Guatemala have many friends. People from all over the world helped through their gifts to UNICEF. Boys and girls in the U.S. and Canada had collected money for UNICEF at Halloween. The money in the orange Trick or Treat boxes was used to buy tents and blankets and medicines and bandages. Some were stored to be ready for such emergencies. UNICEF made available $100,000 immediately and within a few hours of the quake was providing tents and blankets as well as medical supplies and water supply equipment.

There are many stories of kindness and unselfish help following the earthquake. The Guatemalan Scouting Association volunteered to help UNICEF distribute food and emergency supplies. The Scouts have also helped in rebuilding schools for the Guatemalan children. UNICEF is helping by providing hammers, nails and other such materials for the volunteers to use.

But rebuilding Guatemala will take a long time and much help is still needed. UNICEF is now working to raise $3 million for the longer term to provide Guatemalan children with basic services.

A little more than a year before the Guatemalan earthquake, there was another earthquake which killed 5000 people and injured several times that number. Severe damage was done to over 10,000 homes, with many totally destroyed. Whole villages were wiped out. Large numbers of cattle and other animals died. Schools, market places, roads, bridges, and even terraced fields and irrigation systems were destroyed. From the destruction you might expect that this was a <u>major</u> earthquake like the one in Guatemala. But it was not. It barely qualified as a moderate earthquake.

The Pakistan earthquake of December 28, 1974, registered only 5.5 on the Richter Scale. This was two full number steps below the 7.5 quake in Guatemala. Do you remember how to compare earthquakes on the Richter Scale? One full step is 60 times greater in <u>magnitude</u> or energy released inside the earth's crust. Thus the Guatemala quake was two steps higher, that is 60 times 60, or 3600 times more powerful than the Pakistan quake! This may be hard for you to believe when the number killed and injured in Guatemala was only four or five times greater. But there were some important things different about the environment in these two places.

Although Guatemala has high mountains, much of the land is fairly flat along the Motagua Fault, the center of that quake. Most of the mountains are not nearly as steep as that area of Pakistan at the western end of the Himalayas. But one of

the biggest differences is what the population has done to the environment! In Pakistan the population grew larger and people moved higher on the slopes of the mountains. Wooden timbers for building were cut farther up on the slopes. Larger numbers of goats and other animals grazed on the little grass on the high slopes. Farmers planted crops high and higher. Finally, the deforestation, the overgrazing, and the extension of cropping did great environmental damage to the land. Erosion made great cuts in the slopes and steep gorges in the mountainsides. Great sections of earth and rock were weakened by lack of true roots and other vegetation.

When an earthquake of small or moderate strength strikes such an area, the damage is always much greater. The farms and villages in the steep walled valleys and the Indus River valley itself suffered great destruction. There were reports of a terrible "rain of boulders" and large landslides. These landslides set off by the earthquake were bad enough as immediate killers. But they also buried the valuable fertile soil under thousands of tons of boulders and filled in reservoirs needed for irrigation. Thus, long after the shocks and tremors were over, the earthquake still affected their food production. However, immediately after such an earthquake disaster in the middle of the winter, many children who survive the landslides and collapse of their homes, risk dying from exposure to the cold. The government of Pakistan quickly called for blankets, medical supplies, and tents to save the lives of the homeless and injured. Again UNICEF was among the first to respond with over $150,000 worth of emergency aid. Within 24 hours of the order nearly 2000 tents were airlifted from New York to Rawalpindi, Pakistan. There they were trucked immediately to base camps at points where the roads were blocked by landslides. From there Pakistani helicopters carried them into isolated areas as they did with bales of warm blankets supplied by UNICEF. (See the pictures in the wallsheet showing the trucks loading bales of blankets and the helicopter picking up bales and other supplies to fly to victims of the earthquake.)

Many people work together and depend on each other in time of emergencies. So do many organizations. Both the United Nations Disaster Relief Organization and the United Nations Development Program made special contributions of $20,000 each to UNICEF. Pakistan International Airways flew the supplies from Kennedy Airport in New York without charging UNICEF. Many volunteers from a variety of other private and government offices helped in every way possible.

Shortly after the quake a team of UNESCO seismologists was sent to study the earthquake's movements and help the government plan ways to avoid such disasters in the future. The Pakistan Forestry Service is conducting experiments and planting more trees on the slopes. Other agencies are trying to help farmers plan ways to protect their environment and themselves at the same time. These include building better terraces, planting fruit and nut trees on steeper places instead of growing grain, and teaching farmers generally about good conservation practices. It is also important for them to learn how to build safer homes from simple, inexpensive materials. (Houses made of mud and wattle with strong timber supports withstood the earthquake where they were not struck by boulders and landslides.)

But the problems in northern Pakistan are still great. The lesson Nature teaches us all is that we must take care of our environment or it will not take care of our needs. We must learn that we are all interdependent with our environment.

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Things to Remember

We all live on the very thin crust of the earth's surface.

This crust is broken into several large sections called plates.

The movement of these plates, sometimes called continental drift, causes earthquakes.

Earthquakes can happen anywhere in the world.

When major or great earthquakes strike near cities and towns, people are often killed or injured, and their homes, schools, and other buildings may be destroyed.

At such times people depend more on each other, and that's waht UNICEF is all about.

You can help other children in earthquake town areas through UNICEF.

United States Committee for UNICEF
SCHOOL SERVICES
A future for every child.

WORLD ENVIRONMENT -- OUR OCEAN SEAS AND
THE WATER CYCLE

Objectives: To demonstrate the importance of water to all forms of life on this planet and the need to care for our water environment;

To provide simple demonstrations of the hydrological cycle (water cycle);

To show how the oceans relate to everyone's basic needs and how we depend on the seas for many things we use in our daily life;

To show how the actions of each one of us affect the water environment we all share on this planet.

Materials: A classroom globe

"Water, water..." issue of UNICEF's World

Three clear drinking water glasses, a glass flask, several small clean glass bottles for collecting water specimens, a watch glass or similar shallow glass dish or dishes

Celery, potatoes, apples, oranges, cucumbers, or other similar fruits or vegetables

Red and blue food coloring and salt

Heating device for boiling water

8 to 12 inch square of grassy sod and similar square of bare earth

Two trays or shallow aluminum pans and two basins or pans large enough to catch runoff from trays

Two dozen ice cubes and two small pieces of thin cloth

Two sprinkler cans and a large funnel (plastic gallon jugs can be made into sprinklers and a funnel can be made from an inverted plastic gallon jug with the bottom cut out)

Washed silica sand, at least a half gallon

Coliform bacteria test kit

Administrative Offices: 331 East 38th Street, New York, N.Y. 10016. (212) 686-5522

Levels: K-3 and 4-8

Procedures for Kindergarten through Primary Grades

Although the concepts and objectives in this lesson may seem somewhat complex for teaching at these levels, it should be noted that young children are naturally attracted to water. Since most children love to play with water, this natural inclination and interest can be used to advantage in teaching this unit to young children.

In teaching the concept of water as important to all forms of life, we must first link directly with the children's experiences the importance of water to their lives. The following capitalized parts may be read to the children as they are or paraphrased as appropriate for your class:

WHAT IS WATER? WHO NEEDS IT?

Hold up a clear glass container of water for all to see. Accept all answers and continue the discussion until each child so motivated has an opportunity to respond. Water is something we all take so much for granted that we seldom think of defining it. The World Book Dictionary lists its first definition as:

> The liquid that constitutes rain, oceans, rivers, lakes, and ponds. Perfectly pure water is a transparent, colorless, tasteless, scentless compound of hydrogen and oxygen. It freezes at 32° Fahrenheit or 0° Centigrade, boils at 212° Fahrenheit or 100° Centigrade.

Some children may surprise you and use ice, steam, moisture in the air as examples of water. If not, try to ask questions that suggest water might sometimes be frozen solid, boiled, or evaporated.

Many answers may emerge in response to WHO NEEDS IT? Some may think first of fish and other forms of animal life that live in the water. Some may think of plants and other forms of vegetable life. Others may think first of our need for water to drink, to cook, and to wash with. The important concept for children to develop is the idea that we all need water.

WHERE DOES WATER COME FROM?

Answers will range from the water faucet and drinking fountain to the sky or wells and river, lakes, and oceans. In the discussion help children see that all answers are right. Water does not come from any one place. All water we see and use has at one time or another been in the sky, under the ground, in a stream or lake, and in the ocean and many other places between.

MOST OF THE WATER ON OUR PLANET IS IN THE OCEANS. LOOK AT THE GLOBE. CAN YOU SEE THAT THE OCEANS COVER ABOUT THREE TIMES AS MUCH OF THE EARTH AS THE LAND DOES? THIS WATER IS ALMOST ALL SALT WATER. ONLY A VERY SMALL AMOUNT OF WATER (about three percent) IS WHAT WE CALL FRESH WATER. MOST OF THIS FRESH WATER IS FROZEN NEAR THE ARCTIC AND ANTARCTIC REGIONS AND IN SNOW FIELDS AND GLACIERS ON HIGH MOUNTAIN TOPS. THE FROZEN WATER MELTS VERY SLOWLY. IN SOME PLACES IT MAY STAY FROZEN FOR HUNDREDS OF YEARS. THIS MEANS THAT WE HAVE VERY LITTLE FRESH WATER TO USE, AND WE MUST USE IT WISELY. WE WILL LEARN MORE ABOUT FRESH WATER LATER.

WHERE DOES WATER GO?

This is a very open-ended question. Many children will talk of water running in small streams into larger streams and rivers and finally into the seas and oceans. This idea of the interrelationship of all water is important. A delightful storybook enjoyed by young children for many years may be shared at this time, Paddle to the Sea by Holling C. Holling.

Water in Living Things

Another kind of answer to this question is also important. WATER GOES INTO AND BECOMES A PART OF ALL LIVING THINGS. Explain that each of them is made up of more than one-half water -- more nearly two-thirds. ALL PLANTS AND ANIMALS ARE MADE UP OF A LARGE AMOUNT OF WATER. To demonstrate this, ask children to do a simple experiment. Bring various fruits and vegetables such as potatoes, apples, oranges, or cucumbers to class. Have the children weigh each one on a small sensitive scale and record the weight. Then have them carefully cut each one into very thin slices so that several surfaces will open to the air. These slices should then be placed in a pan or on sheets of aluminum foil or wax paper to protect window sills and furniture from stains. Let them dry for two or three days and weigh them again. Then compare the before and after weights.

WHY ARE THEY LIGHTER NOW? THE DIFFERENCE BETWEEN THE TWO WEIGHTS IS THE WATER WHICH WAS LOST. WHERE DID THE WATER GO? DO YOU THINK PART OF THE WATER FROM THE FRUITS AND VEGETABLES THAT DRIED OUT IN YOUR ROOM MAY NOW BE A PART OF YOU? HOW COULD THAT BE? Explain that they were breathing the air in the classroom while the water in the fruits and vegetables was evaporating.

This experiment can be done in less time by placing the slices in direct sunlight and can help introduce solar evaporation to the children. Also a variation of the evaporation experiment on page four of the "Water, water..." issue of UNICEF's World can be achieved by placing half of the slices in the sunlight and half in the shade.

IF YOU HAD EATEN THE FRUIT INSTEAD OF CUTTING AND DRYING IT, WHERE WOULD THE WATER BE?

Explain that part of the water would stay in their bodies for a while, while part would evaporate from their skin as perspiration, and the rest would be passed through their bodies as waste water.

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Another important concept to be developed in this lesson is the importance of water quality. If living things, plants, and animals are to grow and be healthy, they need clean, fresh water. The next exercise can help children see that just any water will not do.

Fresh Water and Salt Water

WE LEARNED BEFORE THAT MOST OF THE WATER ON OUR PLANET IS SALT WATER. HUMAN BEINGS AND MANY OTHER LIVING THINGS NEED FRESH, CLEAN WATER TO LIVE.

To demonstrate this need, two small, inexpensive potted plants may be used. Have the children observe each one carefully and record the size, color and shape of each plant and its leaves. Then add fresh water to one plant and salty water to the other. (Mix about one teaspoon salt in a half cup of water.) Observe them closely at the beginning of the day and at regular intervals each day. Record the difference in the health of the two plants.

Explain that the salinity or saltiness of water is only <u>one</u> problem we must be concerned with. There are many other things that make fresh water unsafe or unusable for certain needs. (See suspended solids and bacteria exercises on pages six and seven of this unit.)

WATER MIXES WITH MANY THINGS, AND THESE MIXTURES ARE CARRIED INTO PLANTS WHEN THEY ARE WATERED AND INTO ANIMALS WHEN THEY DRINK.

Red, White, and Blue Celery

You can easily demonstrate how things travel into plants from water. Place a few drops of food coloring in two glasses of water. For an interesting color effect, use one glass with red coloring and one with blue and keep a third (control) glass with clear water only. Put several freshly cut celery stalks in each glass. Let stand overnight and cut across the stalks at an angle. Then have the children observe closely how the food coloring was carried along inside of the stalk. Explain that all living things use water to carry various nutrients from cell to cell, just as human beings use water to carry nutrients to all parts of their bodies. Thus, it is important that the water we drink have nothing added or mixed in it that would be unhealthy for our bodies.

Refer to the <u>UNICEF's World</u> "Water, water..." edition. Emphasize how most of us just take clean water for granted. We seldom get sick from water in our country. Explain that children in many parts of the world suffer and die from many diseases caused by unsafe water. Then read about "The 48-Hour Miracle" that UNICEF is helping to bring to many children in villages in Asia, Africa and Latin America.

Procedures for Middle and Upper Grades

With a somewhat more sophisticated approach, intermediate grade and junior high level students can also gain from discussing some of the same basic questions introduced in the preceding section for K-3 use. (Conversely, K-3 children as well may benefit from this section where the teacher chooses to adapt it to the level of interest and ability of a particular group.) However, older children will be better able to conceptualize cause and effect relationships over a greater time period and see a more direct relationship between their actions and the quality or deterioration of our water environment. They will also be better able to conceptualize the hydrological cycle and see the increasingly difficult problems of providing enough fresh water for an ever-expanding population of water users. As was introduced previously, 97 to 98 percent of the water on our planet is ocean water. The implications suggested by these figures are basically twofold: (1) We must exercise great care in planning the wise use of our very limited fresh water resources; (2) If the world population either continues its present growth or increases its per capita demand for fresh water, we must find practical ways to convert ocean water to fresh water.

We offer the following series of experiments/activities designed to help students understand the water cycle and humankind's interdependent responsibility for the water environment.

Demonstrating the Water Cycle

One of the simplest ways to see the physical processes of the water cycle as it exists in nature can be demonstrated in just a few minutes with easily accessible materials. Heat some water to the boiling point and pour it into a (preheated) drinking glass. Rotate the glass carefully until the sides are moistened to the top. Put some very cold water in a flask or other glass container which will rest on and slightly down in the glass of very hot water. (If another glass is to be used, be certain that it is of a much greater cone shape to avoid the top glass sticking or causing the bottom glass to break.)

The students will observe water evaporating from the hot water source, condensing on the bottom of the cold water container, and falling back as precipitation into the hot water. Discuss these steps of the water cycle and ask for examples of their parallel steps found in our natural environment.

Simulating a Simple Watershed

A simple way to demonstrate a variety of natural phenomena in the use and misuse of fresh water in a watershed area can also be done in the classroom with readily accessible materials. Cut a small piece of sod fairly well filled with a healthy grass cover. It need be no larger than an 8 to 12 inch square. Make another piece of similar size, using bare soil. To begin, both pieces should be

equally moist throughout. Place each on a shallow pan or cookie sheet to allow maximum drainage. Elevate one end of each model watershed with a brick or similar object. Be certain the elevation is the same for both models, approximately 10". The low ends of the trays must be placed in a basin or cake pan in such a way as to catch the runoff from each tray. Without breaking either piece, try to see that the sides of the two squares on the trays are slightly higher than the center, forming a valley.

Then place an equal number of ice cubes (a dozen or more) in a thin cloth or netting across the highest end of the valley on each square. Sprinkle the ice cubes and cloth with an equal amount of warm water to initiate more rapid melting. Additional sprinkling may be done as needed. This procedure can be used to simulate the action of spring runoff from melting snow and ice. The experiment can also be done in a shorter time period by slowly pouring equal amounts of water from sprinkler cans on each model watershed piece. If sprinkler cans are not available, plastic gallon jugs with small holes can be used. This procedure can be used to simulate the action of rain on watersheds.

In either case students will observe:

(1) That the water is retained better by the sodded watershed model;

(2) That the water which runs off of the sodded piece is cleaner than the runoff from the bare soil watershed;

(3) That small ridges of erosion begin to show on the bare soil model.

Discuss parallel examples of this found in real watershed areas and the actions that can be taken to better control rapid runoff (flooding), erosion, and stream pollution by silting. How can the actions of each one of us make such problems better or worse? Also discuss what happens in such streams to the various forms of life that depend on a clean water environment. What must be done for human beings to use such water?

A Water Filtration Model

A further exercise that is not difficult and that requires simple materials can demonstrate one way to treat dirty, polluted water. First, make a simple model <u>water filtration</u> system. Use a large funnel (or construct a funnel-shaped water resistant container such as a plastic gallon jug with the bottom cut out and small holes punched in the screw top). At the bottom of the funnel place a piece of folded cloth to keep sand from being washed through. Then fill the funnel with clean washed silica base sand. Take muddy water, (visibly polluted water such as the water from the bare soil watershed experiment if done in sequence) and pour it into the top of the funnel, letting it filter slowly through the sand and collect in a clean glass below. Repeat the process if necessary until water is noticeably cleaner.

Suspended Solids in Water

Another simple experiment can be used to demonstrate suspended solids in polluted or dirty water. Suspended solids can be from a wide variety of sources, but they chiefly consist of silt, living or dead animals, animal tissue or wastes, human sewerage, and industrial wastes.

Have students collect a variety of visibly dirty water samples from nearby rivers and streams. Try to get samples from above and below outlets for local industries and city or town outlets of waste water. Also collect samples from lakes, farm ponds and from street gutters after a rain storm. If your school is near a sea coast or sound or some other saltwater inlet, collect and compare saltwater samples, too. (Be certain to caution students to use care and wash their hands after collecting any samples.)

Bottles of clear glass of equal size should be filled and labelled as to source. Then have students shake the bottles vigorously and record the different times necessary for the water in each bottle to clear. Also compare the amount of solids that settle out in the bottoms of the bottles with the volume of clear water on top.

Questions for discussion:

(1) Which water sources seem to have the most suspended solids?

(2) What might some of these solids be?

(3) Do some samples have an area of settled out solids at the bottom with clear water above and yet another layer of matter at the top? If so, what does this indicate? (Example: lighter-than-water materials such as oil, grease, or other petroleum products or other particles of matter that float.)

(4) Is the clear water now less polluted? Is it unpolluted?

With regard to question #4, students should know that removal of suspended solids and floating debris or oils is an important first step in treating polluted water. However, only a test for bacteria and other dissolved materials can determine the drinking quality of water. Sewerage treatment plants have holding tanks and filtration systems where such suspended and floating material can be removed, but the clear water is then treated chemically.

Testing for Bacteria

There are various tests and chemical treatments for bacteria which are described in chemistry and other science books, but few are easy and safe for elementary school classroom activities. For this reason we suggest using a test

kit without harsh chemicals, such as the coliform test kit prepared by the Kemtec Education Corporation of Kensington, Md. (See bibliography and resources for address and price.)

Use water from several of the fresh water sources sampled in the previous exercise as well as clear water samples. Place one milliliter or about 15 drops, approximately one-fourth teaspoon, in a test vial and store in a warm place for 24 hours. If coliform bacteria are present, the purplish solution in the vial will froth and turn a yellowish color. If you have enough test vials, let each student test a different source, listing the time and place each sample was taken and the results observed.

Coliform bacteria are a particular bacteria which come from the intestinal tract of animals, including humans. High levels of coliform may indicate a serious pollution of the water source. It is important to note that the frothing of the liquid in the vial and the color change does not itself indicate the water source is polluted by any other specific forms of bacteria, but rather that it contains coliform bacteria, and more testing is necessary to determine just how it may be polluted. Neither does an absence of a positive reaction assure us that the water is unpolluted by other forms of bacteria. Nevertheless, this is a very important test, as the amount of coliform is most often the main factor in testing whether or not a stream or other water source is likely to be polluted.

A Simple Saltwater Experiment

The following exercise can help students learn more about salt water and demonstrate one of the properties of a solution, as well as demonstrate the power of the sun in the evaporation process.

Put a small amount of clean sea water in a "watch glass." If sea water is not available, mix 5 grams (one teaspoon) of table salt to 100 grams of water (a little less than a half cup) and stir vigorously. Although a watch glass is preferable, other small glass dishes may be substituted if several students want to try this at the same time. Use equal amounts of the same salt solution. Some glass dishes may be placed in a tightly closed container, set out in the open classroom, placed under a lamp, in a shady area, and others placed in full sunlight as much as possible. Have students record the conditions under which their test dishes were placed and the approximate time required for the water to evaporate. Compare and discuss these differences.

In all cases have students observe the material remaining in the watch glass or dish. Taste the residue. (Samples should be from basically clean sources; however, point out that bacteria cannot live in a dry salty environment and thus salt is often used as a preservative where refrigeration is not readily available.)

Why was the salt residue not virible before the water had evaporated? Explain that real sea water is a solution of water and various mineral salts. In a solution the dissolved mineral salts are not visible.

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Point out that the sun has a very great power to evaporate water, and this solar power is the primary force in the dynamics of the hydrological or water cycle.

Make Your Own Solar Still

An optional project that might be undertaken by an interested student or group of students is that of making a small-scale solar still. There are better and more detailed descriptions than we can offer here in various science books, and we recommend student research before attempting to build one. However, a solar still is a simple device which can be used to convert salty (saline), brackish, or other polluted water into fresh, clean water. It can be built relatively easily from readily available, inexpensive materials.

A pan of impure water is enclosed by a sloping transparent cover, trapping both solar energy and the water vapor heated by that energy. As the water vapor comes in contact with the sloping glass, plastic, or other transparent material, it condenses and runs down the slope into a second pan or trough which is used to catch and store the distilled water. Such a simple still can demonstrate on a small scale a process that may become more widely used on a large scale as clean fresh water is found to be increasingly scarce (due to increased population and/or increased per capita consumption).

How We All Depend on the Seas

This is one exercise that students at all levels can do. Challenge them to make a list of the many ways that they and their families depend on the oceans and seas. Although the lists at lower grades will more likely be shorter, introduce the exercise at all levels by initiating a discussion of some of the various categories to be included. For example, the oceans and seas as:

(1) fisheries; (2) aquaculture "farms" and other food sources; (3) mineral resource beds; (4) transportation routes; (5) tidal power sources; (6) research laboratories; (7) recreational areas; and (8) settings for art work and other aesthetic uses.

Some students will need more introductory discussion than others, but those who appreciate a challenge should need only a minimum of discussion. Followup discussions should include ways in which we work together and depend on each other as we all share the resources of the seas to meet our common human needs. Emphasize our increasing interdependence as we depend more on the seas.

For an additional exercise for those students who need further challenge in this area, ask them to make a list of things they and their families have and use that are totally unrelated to the oceans and seas. Point out that nothing should be on that list that has in any way come from the sea or is made up of materials or living things that depend in some way on mineral resources or any form of life

from the sea. Note that this is one of those rare assignments where the most thoughtful students will likely produce the shortest lists.

Conclusion

In summary, we know in general how important our water environment is. But sometimes we forget it or act as if we did not really believe it.

We know that the seas cover three-quarters of the earth's surface. But that can be misleading if we think there is an inexhaustible supply of water. Few people realize the very small amount of water there is on our planet. According to Jacques Cousteau, "If the earth were the size of an egg, all the water and all the oceans, streams and glaciers would be but a single drop on that egg's shell." That drop of water could not be spread out to cover three fourths of the egg's surface because of the surface tension of the water droplet. If it could be done, that very fine layer of water would then compare with the average depth of our oceans on this planet.

The fact that our water environment is so limited is even more difficult to accept when we remember that only three percent of that drop of water would be fresh water and that much of it would be frozen in snow and glaciers.

We know that all life depends on water in some form, in the ocean, on land, or in the air. Without it no form of life on our planet could exist. Even those few simple organisms that can survive without air must have water.

Although few of us have ever had to go without water for very long, we know what it is like to be thirsty on a hot, dry day even for a short time. We can understand why it is very important for children all over the world to have safe, clean water to drink. For this reason in more than 70 countries UNICEF is helping to provide safe, clean water for children. Refer to the enclosed "Water, water..." issue of UNICEF's World. Also see the enclosed picture sheet "Global Interdependence and Worldwide Weather" (part of the weather unit). Note the two pictures of drought above the caption "Too little water and its effects on land and people," and the third picture showing a UNICEF well-drilling rig in operation.

We know that we are all dependent on such fresh, clean water to drink if we are to live. But it is harder to see how we are all dependent on the oceans and seas, too. Many of us live far from any great body of water, and it appears that we do not depend on the seas for our life. But we must remember that if it were not for the evaporation of water from the seas into great cloud and weather systems, our fresh water sources would soon dry up. And we are equally dependent on the seas for our food, whether or not we ever eat fish or seafoods directly. The plankton, small organisms sometimes called the "grasslands of the sea," absorb the mineral nutrients from the sea. Other forms of life in the sea feed on the plankton, and a variety of birds and land animals eat them. Through this complex food chain, a higher order of animals is nourished at each "link" in the chain, and eventually, at one level or another, human beings depend directly or indirectly on food from the sea.

Discuss and emphasize the following points. We all have a vital stake in protecting our water environment in our local community and in our global seas. If we pollute our water, we hurt others and ourselves. If the industries we support with our purchases of goods and services pollute our water with industrial wastes, we also have responsibilities for that, too. We must choose more wisely what we buy and consume, and we must insist that these industries use methods and materials which will not destroy our water environment in producing those goods and services. The effects of our actions are interdependent with each other and the environment we all share. Some say we and our businesses and industries cannot afford to do what is necessary for a clean water environment, but we must consider the cost to all of us if we fail to do so.

> If we aren't willing to pay the price for protecting the seas environment, we will ultimately have to pay the price of destroying it.

Read the above statement by the Office of International Environment Affairs of the Sierra Club. Ask each student to think carefully about it. What price might each of us have to pay eventually if we fail to protect our environment?

* * * * * * * * *

Careers and Water Environment

With the greater awareness of the importance of our water environment, there are increasing opportunities for young people to work in water-related careers. Discuss some of these careers and invite school counselors and resource persons from your community to talk to the class about opportunities for careers in science and technical fields related to areas such as water management, environmental sanitation, and the marine sciences. For a booklet on Training and Careers in Marine Science, write to the International Oceanographic Foundation, 10 Rickenbacker Causeway, Miami, Fl. 33149 and enclose 50 cents. For the slide set "Safe Water: A Basic Human Right," including a commentary and teacher's guide and an activity sheet on water-related careers, write to the U.S. Committee for UNICEF and enclose $3.00.

United States Committee for UNICEF

SCHOOL SERVICES

A future for every child.

WANTED: SOMEONE TO CARE FOR EARTH

Our Earth is in need of pampering. It has been overused, misused, and thoughtlessly exploited in the past with little concern for its future "welfare." Before it's too late, Earth must be spared a thought in the general planning and preparing for life.

After decades of despoiling the air, the water, the soil -- and in so doing also affecting our own well being -- it's time to make amends to the damage we've wrought. Millions of tons of chemicals have pervaded our atmosphere through the use of chemicals which are an essential part of an industrialized setting; pesticides and fertilizers, indiscriminately used, have infiltrated our soil and passed on into the food chain, often to the detriment of both human and animal health. Domestic and industrial waste, sewage and other undesirable matter have found their way into our water and so polluted it for human and animal use.

"Acid" Rain"

A few examples taken at random suffice to indicate the extent to which we have polluted our environment: for instance, more then 100 million tons of sulphur dioxide are released into the atmosphere over Europe and North America every year by industry, according to an Economic Commission for Europe Report published in October 1975. This discharge is responsible for what is known as "acid rain" or "acid snow" over large areas of Europe. What is even more serious, air streams carry the pollutants far from their source of origin -- the heavily industrialized areas of Europe -- to produce the acid rain over southern Norway. In fact, according to the report, distant areas are more severely affected than the point of emission. In Norway fish are depleted in the lakes and rivers and the report predicts that the yield of forests will drop by 50 percent in the next 30 years if sulphur dioxide pollution continues to increase at the current rate. Sweden, Denmark, Finland, the Federal Republic of Germany and the German Democratic Republic are also feeling the adverse effects of acid rain.

In the city of Sao Paulo, Brazil, the River Tiete is visibly polluted by a stench-ridden blanket of brown foam which is an overaccumulation of detergents in raw municipal sewage and industrial wastes dumped into the river. The neighbouring country of Argentina is anxious to prevent the wastes from being carried into the Parana and Plate Rivers to which the Tiete is linked. Sao Paulo has the reputation of being one of the world's most heavily-polluted cities and of the 200 species of birds existant in the area in the early 1900's, only six have occasionally been seen in the last two years -- one belongs to the buzzard family and feeds on garbage!

Dumping wastes into the sea has serious repercussions, as the Japanese of Minimata found out in the 1950's when over 100 people were poisoned by mercury

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polluting the fish caught in Minimata Bay. Effluents from a chemical factory at Minimata containing organic mercury compounds were allowed to flow into Minimata Bay and the fish in the bay accumulated the mercury in such quantities that fish eaters began to show symptoms of poisoning. In 1958, however, the chemical plant stopped pouring its effluents into the bay. This is an extreme case, but it teaches a lesson...

Climatic Changes

Some experts believe that if all known recoverable fossil fuels were consumed -- as is likely within the next 150 years -- atmospheric carbon dioxide (CO_2) could increase by nearly 170 percent. This would be serious since, together with other pollutants, CO_2, by affecting the intensity of incoming solar radiation, could lead to changes in our climate.

Numerous other examples come to mind, but one more will suffice: that of the deadly aerosol sprays used on insects both in the home and in the field. In Britain alone, 10 million such sprays are bought each week. Some scientists are of the opinion -- although others debate this -- that at the present rate of increase, the upper atmosphere of the Earth's layer of ozone could be reduced by 30 percent in 20 years time. This could lead to climatic changes as well as to an increase in ultra-violet radiation, which is a cause of human skin cancer.

Action is Under Way

Serious as the situation is, we may be able to "save" our Earth from further destruction as far as pollutants are concerned, for at both global and regional levels action is underway. The United Nations Environment Programme (UNEP) set up a global environmental assessment program, "Earthwatch", during 1975, as recommended by the Stockholm Conference in 1972 when UNEP was created. Within this program, a Global Environmental System (GEMS) and an International Referral System (IRS) have been set up, the latter providing sources of environmental information. The aim of IRS is to ensure that all information on pollutants and all queries regarding the effect of specific chemicals are available through a co-ordinated process, while GEMS will coordinate monitoring of pollutants and also initiate specific monitoring activities of global concern. Although monitoring and exchange of information exist already at national and regional levels, there is no co-ordination or "focal point" for these activities. If Earth is to be taken care of, it must be done on a global scale to get results.

Data Interchange

IRS will promote world wide interchange of environmental information and provide an internationally acceptable method of identifying and compiling sources of environmental information, so that an enquirer can be referred to a contact or contacts in any part of the world. A headquarters unit based at Nairobi, Kenya, has been set up and this is linked to a network of national (later to include regional and sectoral) focal points being set up all over the world. At the IRS national focal points, Governments can register sources of environmental information covering all aspects -- geographic, ecological, developmental -- to serve the nation and to promote within each country an awareness of IRS' uses. Already nearly 60 nations have agreed to become partners in the IRS network and to set up national focal points. Experts hope that by the end of 1976 IRS will have registered about 10,000 sources of information.

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At present IRS headquarters provides an ad hoc referral service with the co-operation of some IRS partners who permit the Nairobi unit to draw upon their natural resources on a selective basis for the benefit of the international community.

IRS seeks to work hand in hand with other institutions interested in the exchange of specialized information, such as the Universal Systems for Information in Science and Technology (UNISIST) and United Nations Educational, Scientific and Cultural Organization (UNESCO)-sponsored national documentation centers. In late 1975, the International Oceanographic Commission (IOC) accepted an inter-agency co-ordinating role for an inter-disciplinary Marine Environmental Data and Information referral system (MEDI). MEDI is closely linked with the information exchange component of UNEP's Mediterranean Action Plan and with the Food and Agricultural Organization (FAO) Aquatic Science and Fisheries Information System (ASFIS). IRS is also providing financial support to the Environmental Legislative Information System (ELIS) of the International Union for the Conservation of Nature (IUCN) which concerns itself with environmental law, especially in developing countries on a global scale. Similarly, with IRS support, the FAO catalog of Current Legislation on Environment and Natural Resources (CLENR) is being helped to expand its services to developing countries.

Monitoring System

GEMS, another part of "Earthwatch", is a monitoring system co-ordinating regional and other monitoring operations around the world. It includes as an integral part of the system the monitoring components of other members of the UN family.

A monitoring activity now being expanded with UNEP (GEMS) support in the World Weather Watch (WWW) system for monitoring background atmospheric pollution. This has been operational since 1971. Atmospheric baseline stations are being set up on a global basis to measure the chemical composition of precipitation and long-term trends in aerosol and CO_2 concentration which are relevant to the study of climatic changes. Seven such stations are already operational in Canada, United States of America and the Soviet Union. Developing countries will also be setting up similar stations. For instance, Kenya plans to establish one during 1976.

Apart from baseline stations, regional stations are also being set up to measure background pollution, but with the additional aim of studying changes in atmospheric composition related to regional land use practices and the long range transport of atmospheric pollutants. More than 50 regional stations are now in existence and a complete global network would comprise up to 200 stations.

Another project deals with monitoring of oil pollution along the main shipping lanes in the Atlantic and Indian Oceans and is being carried out under the Integrated Global Ocean System (IGOSS) pilot project in marine pollution. UNEP, along with the World Meterological Organization (WMO) and the Inter-governmental Oceanographic Commission (IOC) of UNESCO are jointly involved.

Other monitoring activities involving UNEP include a co-ordinated Mediterranean Pollution Monitoring and Research Programme in which laboratories and institutions in the Mediterranean region will participate; a UNEP/FAO pilot project to monitor tropical forest cover with the aim of defining, systemizing and, if necessary,

adjusting methodologies used and a global assessment of soil degradation (FAO/UNESCO/UNEP) to coincide with the UN conference on Desertification in 1977.

"Earthcare"

Non-governmental groups include "Earthcare", an international conference which coincided with World Environment Day on June 5, 1975, at which scientists, conservationists, diplomats gathered to examine the environmental problems we face. It was co-sponsored by the Sierra Club and the National Audobon Society in the USA. The American World Watch Institute, set up in 1974, is helping research on the monitoring of food and environmental health problems. There are many regional monitoring programs such as the Co-operative Study of Caribbean and Adjacent Regions, the Antarctic Research Programmes and Tsunami Warning System (Japan).

Following 1975 World Environment Day, an "Earthcare" petition with 192,000 signatures from 25 countries was presented to UNEP's Executive Director referring to the protection of the global environment as a basic human right. The petition gave three examples in which human rights were denied: mercury poisoning, neglect of tropical rain forests and the reduction of the ozone layer.

It is a charge that incriminates all of mankind. We are probably all guilty. It is not merely someone or the other person who must act. Everyone of us should maintain a close watch over Earth to restore it to good "health."

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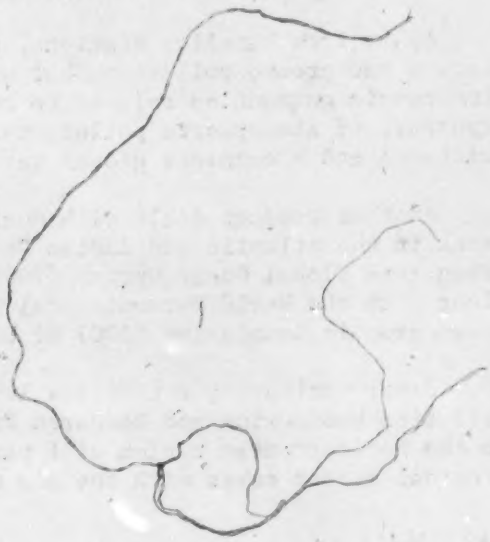
This article was prepared by the United Nations Development Programme (FEATURE/2, March 1976) and distributed through the courtesy of the U.S. Committee for UNICEF. This piece can also be used effectively with the elementary teacher's kit #5420, "Teaching About the Child and World Environment," available from the U.S. Committee for UNICEF for $2.50.



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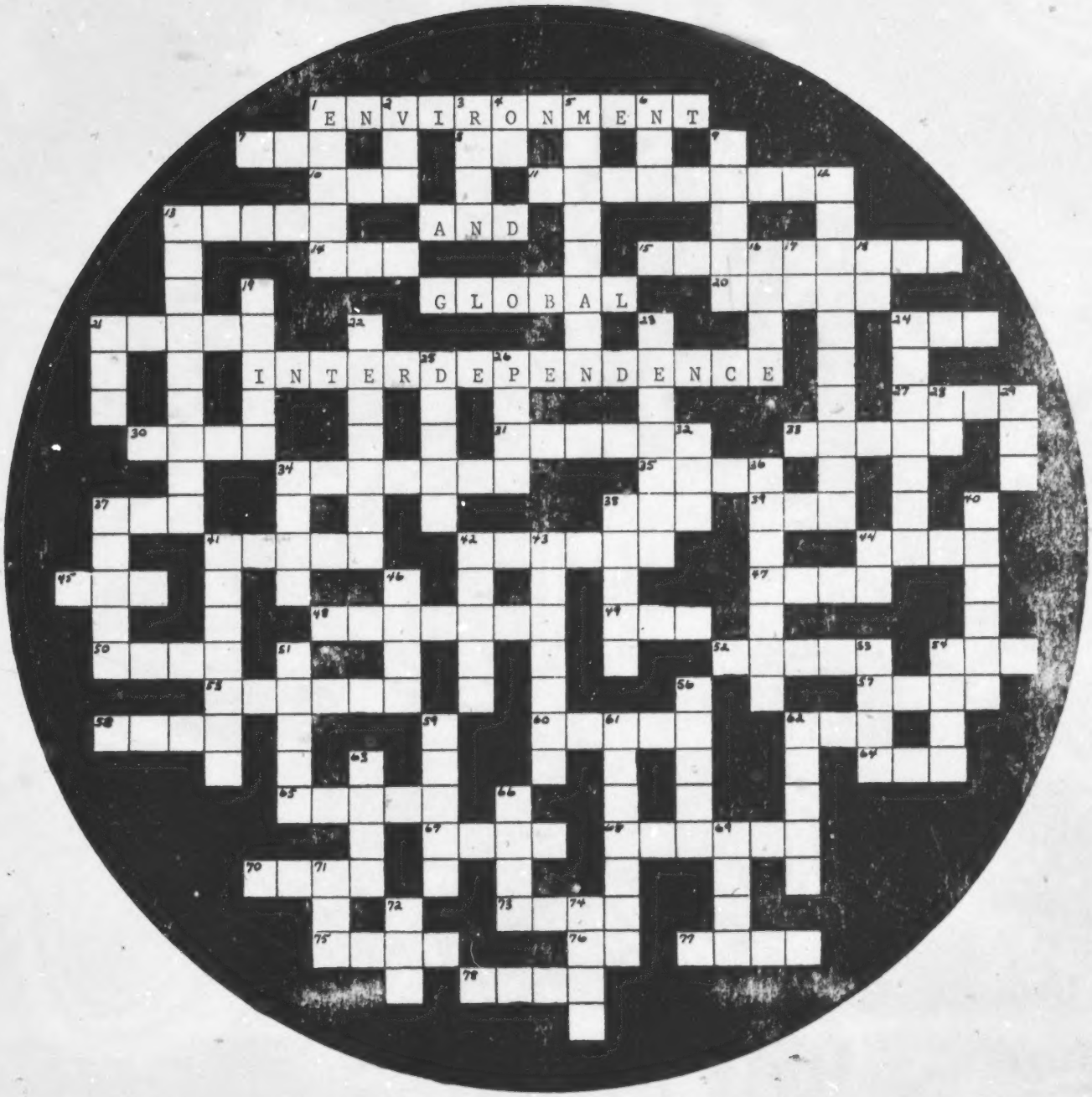
ENVIRONMENT CROSSWORD PUZZLE



3

ACROSS

7. a body of water
8. a small word preceding words beginning with vowels
10. to move swiftly and quickly
11. a bad storm with high winds and much rain
13. the bottom layer of a pizza; also the outer layer of the earth
14. not cold
15. to change from liquid into vapor
20. the opposite of south
21. something that all living things need to survive
24. to give money for; to purchase
27. solid part of the earth's surface; ground or soil
30. when heated this is what ice will do
31. flowers, trees, shrubs, herbs
33. an error; a crack in the earth's crust
34. average weather conditions of a region
35. a circle
37. except
38. a folding bed
39. to not tell the truth
41. the earth and its inhabitants
42. to furnish
44. a source of water
45. 2000 pounds
47. to take interest in
48. to supply or give materials
49. small black or red insect
50. goes with pepper on the table
52. requirements
54. very damp
55. general state of the body
57. that imaginary line on which the Earth rotates
58. movements on the surface of the water often having white caps

ACROSS (CONT'D)

60. the high point of a wave or mountain ridge
62. not "on"
64. to finish or come to a close
65. a puffy, often white, formation in the sky
67. not here; away
68. the layer of the earth beneath the crust; a wooden frame around a firep
70. to cook water until it bubbles
73. to caution
75. the side of, corner of
76. pronoun
77. to warm
78. bread is made in this form

DOWN

1. a planet
2. a small enclosed truck
3. water that falls from the sky
4. upon
5. a land form larger and higher than a
6. neither____
9. large body of salt water
12. a shaking of the earth's crust along a fault line
13. a large land mass
16. the northern most point of the earth is the North _____
17. either___
18. a sigh of relief
19. to float from one place to another
21. to come in first
22. to build again
23. to damage or kill

DOWN (CONT'D)

24. to make dirty; to contaminate
25. imaginary story in our minds during sleep
26. a long narrow tube through which water flows
28. a preposition
29. not wet
32. to place oneself in a chair
34. the center of the earth or an apple
36. a large ice mass
37. how the wind moves
38. not dirty
40. the round, flat objects we eat off of
41. atmospheric conditions on any day
42. to change position; adjust
43. to foretell the future
44. us
46. a winged insect similar to a butterfly
51. fundamental
53. free from danger
54. air movement
56. a spot one can't get off one's clothes
59. a long narrow top or crest of mountains
61. basic part of a substance
62. many times
63. dirt
66. frozen flakes
69. a watch tells this
71. frozen water
72. the time or number of years a person has lived
74. a deep break in the earth's crust

ANSWERS TO THE ENVIRONMENT CROSSWORD PUZZLE

ACROSS

7. Sea
8. An
10. Run
11. Hurricane
13. Crust
14. Hot
15. Evaporate
20. North
21. Water
24. Buy
27. Land
30. Melt
31. Plants
33. Fault
34. Climate
35. Ring
37. But
38. Cot
39. Lie
41. World
42. Supply
44. Well
45. Ton
47. Care
48. Provide
49. Ant
50. Salt
52. Needs
54. Wet
55. Health
57. Axis
58. Wave
60. Crest
62. Off
64. End
65. Cloud
67. Gone
68. Mantle
70. Boil
73. Warn
75. Edge
76. It
77. Heat
78. Loaf

DOWN

1. Earth
2. Van
3. Rain
4. On
5. Mountain
6. Nor
9. Ocean
12. Earthquake
13. Continent
16. Pole
17. Or
18. Ah
19. Drift
21. Win
22. Rebuild
23. Destroy
24. Pollute
25. Dream
26. Pipe
28. At
29. Dry
32. Sit
34. Core
36. Glacier
37. Blows
38. Clean
40. Plates
41. Weather
42. Shift
43. Predict
44. We
46. Moth
51. Basic
53. Safe
54. Wind
56. Stain
59. Ridge
61. Element
62. Often
63. Soil
66. Snow
69. Time
71. Ice
72. Age
74. Rift

Books

Adler, Irving. Weather in Your Life. (New York: John Day Company), 1976. Intermediate.
Approaches such topics as effects of weather, the source of rains and wind, air masses, and weather forecasting.

Anderson, Lonzo. The Day the Hurricane Happened. (New York: Charles Scribner's Sons), 1974. Primary and up.
A moving, delightful story of children experiencing a hurricane hitting the island of St. John in the Virgin Islands.

Feagle, Robert G. and others. Weather Modification in the Public Interest. (Seattle: American Meteorological Society and the University of Washington Press), 1974.
A study for the layman and scientist of the policies and practices of weather modification from several perspectives.

Gribbin, John. Forecasts, Famines and Freezes. (New York: Walker and Company), 1976.
The author examines the enormity of the climate crisis in terms of world economies, food supply and politics. He also reports attempts by scientists to understand the forces that change climate.

Hess, W.N., editor. Weather and Climate Modification. (New York: John Wiley & Sons), 1974.
A resource for anyone interested in the science and technology of weather modication and its legal and social implications.

Navarra, John Gabriel. Wide World Weather. (New York: Doubleday & Company, Inc.), 1968. Intermediate/Junior High.
An examination of the wide-ranging effects of a World Weather Watch of the World Meteorological Organization.

Other Resources and Instructional Media for Teachers

Alexander, Tom. "Ominous Changes in the World's Weather." Reader's Digest. No. 705 (July 1974).
The effect of cooling and heating are equated with fear of a future climatic change, affecting population and food production.

"Climates of the World. U.S. Department of Commerce, Environmental Science Services Administration, Environmental Data Service, Reprinted 1972. Available from the U.S. Government Printing Office. 35 cents.
Good teacher reference covering the features of climate, maps of worldwide temperature, and precipitation.

Giant Hurricane Tracking Chart. Available from the U. S. Government Printing Office. 10 cents.
A 17" x 13" map of the East Coast and Gulf of Mexico. Useful for recording hurricane movement.

Kellogg, William W. Climate Change and the Influence of Man's Activities on the Global Environment. Prepared by Mitre Corporation and distributed by National Technical Information Service, U.S. Department of Commerce, 5285 Pt. Royal Road, Springfield, VA 22151. (September 1972).
A talk presented at a conference on energy, resources and environment.

Schneider, Stephen H. with Lynn E. Mesirow. "The Genesis Strategy: Climate Change and Global Survival." The Futurist Vol. X, No. 4 (August 1976).
Explains climatic fluctuations, predicts further changes in climate and proposes the establishment of agencies to monitor resources and plan needed food reserves.

School Packets on Temperature, Precipitation, Hurricanes, etc. Free on request from the National Climatic Center.

"Servants in Space." Produced by Lewis Research Center of the National Aeronautics and Space Administration. Color sound film, 20-25 min. Available free to schools. To order, write Sunray Films, Inc., 3200 Carnegie Avenue, Cleveland, OH 44115.
Shows the current uses and vast potential of earth-oriented satellite photography and data acquisition.

Weather Maps. Booklet produced by the Department of Earth Sciences, SUNY College at Brockport, Utica Street, Brockport, NY 14420.
Includes information on weather maps and how to use them in local weather study. Bibliography included.

General Environmental Bibliography and Resources
(Including Related Agencies and Organizations)

Books

Adler, Irving, The Environment. (New York: The John Day Publishing Company), 1976. Intermediate.
A description of the life-giving cycles of nature; how these are being disrupted and what we can do (and are doing) to return them to their proper balance.

Bendick, Jeanne. The Shape of the Earth. (New York: Rand McNally & Company), 1965. Intermediate.
The author takes particular interest in the effect of the earth's roundness on all the forces of the earth's outer face, such as climate and weather. Although such other aspects as ice, wind, water, and earthquakes change the design of the face of the earth, the author feels that the earth's roundness will always exert an effect.

Bloome, Enid. The Air We Breathe. (Garden City, NY: Doubleday & Company), 1971. Primary.
Tells how we as individuals can contribute to fight for cleaner air.

Fuchs, Erich. Looking at Maps. (New York: Abelard-Shumand), 1976. Intermediate.
Starting with a child's immediate environment, the author leads the reader into an understanding of map language, map forms, and the various types of maps.

Gavel, Margaret. Sparrows Don't Drop Candy Wrappers. (New York: Dodd, Mead & Company), 1971. Intermediate.
Here are the simple do's and don'ts which show how each and every one of us can help in those small, vital ways to make this world a better place to live.

McCamy, James L. The Quality of the Environment (New York: The Free Press), 1972.
A book acquainting people with all aspects of the environment from a specific and broad base, in order to identify and define the problems, then to investigate ways for bringing about possible change.

Miles, Betty. Save the Earth! An Ecology Handbook for Kids. (New York: Alfred A. Knopf, Inc.), 1974. Intermediate.
This collection of poems, narrations, and projects for children shows some of the earth's problems, describes various solutions, and gives suggestions for related activities. Globally oriented.

National Aeronautics and Space Administration. Earth Photographs from Gemini VI Through VII. (Washington, D.C.: U.S. Government Printing Office), 1968.
Contains a sampling of photographs of terrain and weather taken during Gemini flights.

Shuttlesworth, Dorothy E. Clean Air - Sparkling Water. (Garden City, NY: Doubleday & Company, Inc.), 1968. Intermediate.
Through a story of one community's efforts to combat pollution, we see the plight of all of us affected by foul air and filthy water.

What Are We and You Gonna Do? (New York: Ballantine Books), 1971. Intermediate.
A compilation of children's letters to Senator Gaylord Nelson about the environment.

Wilcox, Howard A. Hot-House Earth. (New York: Praeger Publishers), 1973.
Intermediate/Junior High.
Global heat may become a danger by melting ice caps and flooding coastlines. Cautions and solutions suggested lie in an intensive and immediate development of solar technology -- particularly in ocean farming.

Other Resources and Instructional Media for Teachers

A Dictionary of Air Pollution Terms. Available from the Air Pollution Control Agency, 440 Fifth Avenue, Pittsburgh, PA 15213. Junior High and up.
A four-page folder of common terms in the study of air pollution.

Air Pollution Pamphlets. Free pamphlets can be obtained from your local Tuberculosis and Respiratory Disease Association or the national office at 1714 Massachusetts Avenue, NW, Washington, D.C. 20036.

"A Message to Our 3.5 Billion Neighbors on Planet Earth from 2,200 Environmental Scientists." UNESCO Courier. Vol. 24 (July 1971).
Quick overview of environmental problems.

Career Choices. Available from the Environmental Protection Agency.

Connect. A UNESCO-UNEP environmental newsletter. Single copies free.

Conservation Yearbooks. Information on these available from the U.S. Government Printing Office.

Dawson, Richard G. "Forecasting the Future of Spaceship Earth: An approach to Environmental Education." The Science Teacher. (December 1973).
A unit helping students identify current problems and future needs on "spaceship earth."

"Ecology and Environment: A Selected List of Books, Filmstrips, Recordings Transparancies, Slides for School Libraries." (Albany, NY: The State Educational Department Bureau of School Libraries), 1973. A 12-page bibliography.

Editors' Declaration on Interdisciplinary Environment Education." Social Education. Vol 39, No. 2 (February 1975).
A joint statement viewing the environment as an "interrelated web of components" discussed from a three-point position: integrated design, interrelationships of environment, and interdisciplinary solutions.

Elementary School Packet of Publications. Available from the Environmental Protection Agency.

"The Environment Crisis." Social Education. Vol. 35, No. 1 (January 1971).
Special issue devoted to environment from a global perspective.

Handbook of Environmental Education Strategies. (Albany, NY: State Education Department), 1972.
A compilation of learning activities centered on basic concepts underlying man's natural and social existence.

Kellner Robert. "To Catch a Falling Star" Environment Education Implementation Strategy Handbook Produced by Project I-C-E.
This handbook is a detailed description showing step-by-step the process of implementing an environmental education program in a school district.

King, David C. and Cathryn J. Long. "Environmental Issues and the Quality of Life." Intercom. No. 82 (September 1976). Available from the Center for Global Perspectives.
Considers natural, built, and social environments and how humans respond to and shape their environments.

Marlett, Robert, editor. "Current Issues in Environmental Education -- 1975."
Available from the National Association for Environmental Education, $3.25.
Good teacher resource material on educational programs, materials, and general environmental concerns.

Nature and Resources. UNESCO publication. (Available from UNIPUB, P.O. Box 443, Murray Hill Station, New York, NY 10016. $2.25 per single copy, $6.00 yearly subscription.)
A quarterly newsletter including scientific research reports.

Pollution Game. Produced by Games Central, c/o ABT Associates, Inc., 55 Wheeler Street, Cambridge, MA 02138. $30.00. Teacher's Manual. Grades 5-12.
Students weigh the problem of the consequences of pollution (air, noise, and water) against the cost of abatement programs.

Primary Science Discovery Series: Concepts and Processes. Instructor Curriculum Materials. 8 sets. $4.95 each. Available from Instructor Publications, Inc. Danville, NY 14437.
Each set of full-color posters considers one topic divided into nine areas, with teacher's notes. Three sets related to Air and Weather, the Earth Around us, and the Waters of the Earth.

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Project I-C-E Catalog of Media Resources. Available from the Instruction-Curriculum-Environment Center.
An annotated bibliography of films, filmstrip, kits, games, books and booklets, and educational programs on the environment.

Quigg, Philip W. "Environment: The Global Issues." Headlines Series. No. 217 (October 1973). Available from the Foreign Policy Association, 345 East 46th Street, New York, NY 10017 $1.25.
Special environment issue on world resources, development, growth limitations, and the UN Conference on Human Environment.

Ranger Rick. A children's nature magazine published by the National Wildlife Federation. Filled with facts, photographs, games, puzzles, and projects as well as trip suggestions. Single copies of educational reprints free.

Sammartano, Susan. "Environment and Development." Communique: No. 19 (April 1973). Available from the Overseas Development Council, 1717 Massachusetts Avenue, N.W., Washington, D.C. 20036.
A pamphlet on pollution as a threat to the environment. Emphasizes the roles and responsibilities of developed and developing countries.

Science Investigation Series: Self-Directing Activities for Middle/Upper Grades. Instructor Curriculum Materials. 6 sets. $4.95 each.
A variety of full-color study posters, including study and work sheets. The topics include: Plants, Air and Weather, Earth Changes, Animals, Water, Energy and Matter.

Wheeler, James and Nobuo Shimahara, "Toward an Ecological Perspective in Education: Part 1." Phi Delta Kappan. Vol. LV, No 6 (February 1974).
Good teacher reference on the ethical aspects of the ecological crises, and the formation of attitudes and habits of mind and character as they relate to nature.

"World EQ Index" Available from the National Wildlife Federation.
Published annually this pamphlet analyzes our environment in several areas.

World Health. The magazine of the World Health Organization.
Issues devoted to environmental concerns of the air, sea and land include August/September 1971, May 1972, and November 1973.

Your World, My World: A Book for Young Environmentalists: Produced by the U.S. Environmental Protection Agency. 1973. Intermediate.
An excellent booklet touching on needs and problems in our society and what can be done.

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Environment-Related Agencies and Organizations

Air Conservation and Smoking Program, American Lung Association, 1740 Broadway, New York, NY 10019.
Air Pollution Control Association, 4400 Fifth Avenue, Pittsburgh, PA 15213.
American Conservation Association, Inc., 30 Rockefeller Plaza, New York, NY 10020.
American Forestry Association, 919 - 17th Street, NW, Washington, D.C. 20006.
Association for Childhood Education International, 3615 Wisconsin Avenue, NW, Washington, D.C. 20016.
Association for Supervision & Curriculum Development, 1701 K Street, NW, Suite 1100, Washington, D.C. 20006.
Center for Global Perspectives, 218 East 18th Street, New York, NY 10003.
Citizens for Clean Air, 502 Park Avenue, New York, NY 10016.
Conservation Education Association, P.O. Box 450, Madison, WI 53701
The Cousteau Society, Inc., Box 1000, Bridgeport, CT 06601.
Energy and Man's Environment, 0224 SW Hamilton, Suite 301, Portland, OR 97201.
Energy Research and Development Administration, Office of Public Affairs, Washington, D.C. 20545.
Energy Research and Development Administration, Technical Information Center, P.O. Box 62, Oak Ridge, TN 37830.
Environmental Education Project Office, 800 Highview Drive, Antioch, IL 60002.
Environmental Education Task Force, The University of the State of New York, The State Education Department, Albany, NY 12224.
Environmental Protection Agency, 4th and M Streets, SW, Washington, D.C. 20460.
Environmental Science Services Administration, Environmental Data Services, U.S. Department of Commerce, Washington, D.C. 20402.
Friends of the Earth, 30 East 42nd Street, New York, NY 10017.
Food and Agricultural Organization, United Nations, Room 2258, New York NY 10017.
International Oceanographic Foundation, 10 Rickenbacker Causeway, Miami, Fl 33149.
Kemtec Educational Corporation, P.O. Box 57, Kensington, MD 20795.
Lamont-Doherty Geological Observatory, Route 9, Palisades, NY 10964.
Maine Environmental Education Project -- Title III, Yarmouth Intermediate School, Yarmouth, ME 04096.
National Aeronautics and Space Administration, Educational Programs Division, Washington, D.C. 20546.
National Association for Environmental Education, 5940 SW 73rd Street, Miami, FL. 33143.
National Audubon Society, 1130 Fifth Avenue, New York, NY 10028.
National Climatic Center, National Oceanic and Atmospheric Administration, D542, Federal Building, Asheville, NC 28801.
National Council for the Social Studies, 1515 Wilson Blvd., Arlington, VA 22209.
National Earthquake Information Service, Box 25046, Denver Federal Center, Denver, CO 80225.
National Education Association, 1201 - 16th Street, NW, Washington, D.C. 20036.
National Geophysical and Solar-Terrestrial Data Center, National Oceanic and Atmospheric Administration, Environmental Data Service, Boulder, CO 80302.
National Education Association, 1201 - 16th Street, NW, Washington, D.C. 20036.
National Science Teacher's Association, 1742 Connecticut Avenue, NW, Washington, D.C. 20009.

National Wilflife Federation, 1412 - 16th Street, NW, Washington, D.C. 20036.
The Oceanic Society, 3131 Fillmore, Street, San Francisco, CA 94123.
Project ECOS, 845 Fox Meadow Road, Yorktown, NY 10598.
Project I-C-E (Instruction - Curriculum - Environment), 1927 Main Street, Green Bay, WI 54301
The Sierra Club, Office of International Environmental Affairs, 1050 Mills Tower, San Francisco, CA 94104.
United Nations Development Program, One UN Plaza, 16th Floor, New York, NY 10017.
United Nations Disaster Relief Organization, 485 Lexington Avenue, 12th Floor, New York, NY 10017
United Nations Environment Program, 485 Lexington Avenue, 12th Floor, New York, NY 10017.
UNESCO, United Nations Room 2201, New York, NY 10017.
U.S. Geological Survey, EROS Data Center, Sioux Falls, SD 57198.
U.S. Government Printing Office, Superintendent of Documents, Washington, D.C. 20402.
World Metorological Organization, 41, Avenue Giuseppe-Motta, Geneva, Switzerland.

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Environmental Bibliography and Resources -- Water

Books

Asinov, Isaac. ABC's of the Ocean. (New York: Walker & Company), 1970. Primary
Explicit pictorial a-b-c of marine life and resources.

Barlowe, Sy. Oceans. (Chicago: Follett Publishong Company), 1969. Primary.
Introduces oceans, wave action, continental shelves, other undersea formations and a variety of plant and animal life. Suggests new uses of the ocean by "sea farmers" and oceanographers.

Barton, Robert. Atlas of the Sea. (New York: The John Day Company), 1974.
Presents a wide-ranging look at the sea, from the driving force of its tides to the exploitation of its resources.

Behrman, Daniel. Exploring the Ocean: UNESCO and It's Programme. (Paris: UNCECO), 1970.
Deals with exploration, pollution, interdependence of total environment and the future -- "what can be and what should be."

Berger, Melvin. The New Water Book. (New York: Thomas Y. Crowell), 1973.
Upper Primary/Intermediate.
Tells a complete story of water from the water molecule to its properties, its role in life cycles, and its use and misuse. Some water experiments are included.

Berger, Melvin. Scientists at Work: Oceanography Lab. (New York: The John Day Company), 1973
Discusses the daily activities of oceanographers at the Woods Hole Oceanographic Institution and lists some of their current research problems.

Brown, Joseph E. The Sea's Harvest. The Story of Aquaculture. (New York: Dodd, Mead & Company), 1975
Explains reasons for farming the sea and fresh water, and describes farming operations. Well illustrated.

Buehr, Walter. Water: Our Vital Need. (New York: W.W. Norton & Company), 1967.
Intermediate/Junior High.
Background information on water, what it is, and the many ways we depend on it. Good chapter on desalination, but needs updating.

Elliott, Sarah M. Our Dirty Water. (New York: J. Messner), 1973. Intermediate.
Stresses clean water as everybody's business. Shows how waterways and drinking water have become polluted. Discusses ineffective and unenforced laws and points to immediate and future needs in this area.

Fisher, James. The Wonderful World of the Sea. (Garden City, NY: Doubleday & Company), 1970.
Tells the story of the sea -- how man came first to fear it, next to challenge it, and finally to ransack its secrets.

Holling, Holling Clancy. Paddle-to-the-Sea. (Boston: Houghton Mifflin Company), 1941. Primary/Intermediate.
Story of a young boy who carved the figure of an Indian in a canoe, christened it Paddle-to-the-Sea, and set it on a snowbank which the spring sun was turning into a mountain stream. The trip through the Great Lakes, down the Saint Lawrence River, and over Niagara Falls to the Atlantic delightfully demonstrates an important part of the watercycle.

McConnaughey, B.H. and Bayard Harlow. Introduction to Marine Biology. (St. Louis: The C. V. Mosby Company), 1970.
A textbook on marine environment for teacher background. See particularly Chapter 19, "Man's Impact on Marine Environments."

Michelsohn, David Reuben and the editors of Science Book Association. The Oceans in Tomorrow's World. How Can We Use and Protect Them? (New York: Julian Messner), 1972.
Good general book on oceans with emphasis on endangered environment and the future.

Peterson, Ottis. Junior Science Book of Water. (Champaign, Il.: Garrard Publishing Company), 1966. Primary/Intermediate.
Discussion of the nature of water, the water cycle, importance to plants and animals, water pollution, and the oceans. Dated, but the basic water science information and concepts are still useful.

Popkin, Roy. Desalination: Water for the World's Future. (New York: Frederick A. Praeger), 1969.
A thorough examination of the economic and socio-political factors of desalination. Explains the processes used, how each works, where they are useful, and the approximate costs.

Russell, Helen Ross. Water. A Field Trip Guide. (Boston: Little, Brown and Company), 1973.
Discusses the properties of water, the water cycle, the need for water, and its uses by plants and animals.

Stone, A. Harris and Dale Ingmanson. Drop by Drop: A Look at Water. (Englewood Cliffs, N.J.: Prentice-Hall, Inc.), 1971. Intermediate.
A collection of simple experiments dealing with some of the interesting facts about the physical and chemical properties of water.

Other Resources and Instructional Media for Teachers

Coliform Test Kit. Produced by Kemtec Educational Corporation.
25 tubes lactose broth. complete instructions. Cat. Order #3-302...$21.50
Mini-kit, 5 test-tube kit Cat. Order #3-302A...$5.00

By seeing a dramatic color change that occurs in a lactose broth, students can easily and safely test for the presence or absence of Escherichia-coli (indicative of animal waste) in water supply.

Heyerdahl, Thor. "How to Kill an Ocean." Saturday Review (November 29, 1975). Warns of the danger of killing our oceans. Presents plankton as the one most significant protein element in the sea, and its importance to human survival.

Natural Water in Good Shape. Report USGS Circular 460-E. Available free from USGS Branch of Distribution, 1200 S. Eads Street, Arlington, VA 22202. A report summarizing data from hydrological stations in 37 states concluding that monitored streams remain relatively undefiled and that water quality in the natural environment is generally good.

The Ocean. Scientific American (San Francisco: W. H. Freeman & Company), 1969. A portrayal of the ocean as it has become known to scientists in the last two decades. A look at every aspect of the ocean -- its origin, structure, nature, resources, technology, and effect on man. A comprehensive study.

"The Oceans." Produced by Schloat Productions of Prentice-Hall Media, Inc. 2-color sound filmstrip with program guide, 75 frames, 16 min., $44 with disc, $50 with cassettes.
This program shows the importance of the ocean flora and fauna and supplies specific examples to show adaptations and relationships in our increasingly crowded, hungry world.

Sea Frontiers. An illustrated bimonthly magazine produced by the International Oceanographic Foundation covering varying topics relating to the oceans and seas, with a book review section.

Sea Secrets. A bimonthly question-and-answer series published by the International Oceanographic Foundation.

Training and Careers in Marine Science. (Revised, October 1973). 50 cents.
A pamphlet produced by the International Oceanographic Foundation covering oceanography, the necessary training, possible career opportunities, and general reading material available.

"Voices of the Water." Produced by Schloat Productions of Prentice-Hall Media, Inc. 2-color sound filmstrip with program guide. 80 frames, 9 min., $44 with disc., $50 with cassettes.
A sensitive nature appreciation study stressing the urgent necessity for us to abide by nature's rules and maintain the proper balance. Covers such aspects as water/air cycles, food/soil production, decomposition, selection, extinction, interdependence, evolution.

Water: A Precious Resource. photographic display set. Available from the United Nations Bookstore, United Nations, New York, NY 10017. $2.00.
A set of eight 13½" x 19½" color photo sheets, each focusing on one aspect of water, covering the topics of water as vital to life, fresh water, droughts and floods, dirty water, safe water, water freely used and abused, industry, and food from inland and ocean waters.

Books

Anderson, Alan H., Jr. The Drifting Continents. (New York: G.P. Putnams' Sons), 1971. Intermediate.
Excellent coverage of the theory of continental drift, and the forces, movements and resources in the ever-changing crust of the earth.

Branley, Franklyn M. Shakes, Quakes and Shifts: Earth Tectonics. (New York: Thomas Y. Crowell Co.), 1974. Intermediate.
Simple explanations of our changing earth: the evolution of continents and the forces that reshape the face of the earth.

Briggs, Peter. The Great Global Rift. (New York: Weybright and Talley), 1968. Intermediate.
Explores the Great Global Rift system and its effects on our world.

Brown, Billye Walker and Walter R. Brown. Historical Catastrophes: Earthquakes (Reading, Ma: Addison-Wesley), 1974. Intermediate.
Discusses major earthquakes throughout history and the means developed to measure their force.

Calder, Nigel. The Restless Earth: A Report on the New Geology. (New York: The Viking Press), 1972.
An in-depth pictorial description of the theory of plate tectonics.

Coffman, Jerry L. and Carl A. von Hake, editors. Earthquake History of the United States. Revised edition, Publication #41-1. Produced by the National Oceanic and Atmospheric Administration, Environmental Data Service. Available from the U.S. Government Printing Office. $2.80.
Includes graphs and maps of prominent earthquakes in the U.S. through 1970.

Crayton, Keith. The Crust of the Earth: The Story of Geology. (Garden City, NY: The Natural History Press), 1967.
Discusses the structure of the earth and the forces that change its face.

Golden, Frederick. The Moving Continents. (New York: Charles Scribner's Sons), 1972. Intermediate.
A scientific "detective story" describing the step-by-step process of the earth scientists who pieced together fragmentary evidence, to confirm their theory of plate tectonics.

Ladyman, Phyllis. Inside the Earth. (New York: William R. Scott, Inc.), 1969. Intermediate.
Combines words and pictures to describe the earth's structure and natural phenomena such as geysers, earthquakes, and volcanoes.

Lauber, Patricia. Earthquakes: New Scientific Ideas About How and Why the Earth Shakes. (New York: Random House), 1972. Intermediate.
Describes famous earthquakes, and explains new theories about their causes.

Lauber, Patricia. This Restless Earth. (New York: Random House), 1970. Intermediate.
Discusses recent theories on the forces that shape and change the earth.

Matthews, William H., III. The Story of Volcanoes and Earthquakes. (Irving-On-Hudson, NY: Harvey House, Inc.), 1969. Intermediate.
A study of volcanoes and earthquakes and their effects and influences on the face of the earth as well as on human societies.

May, Julian. Why the Earth Quakes. (New York: Holiday House), 1969. Intermediate.
Simplified explanations of continental drift, the currents in the earth's liquid mantle, and earthquakes.

Navarra, John Gabriel. Nature Strikes Back. (Garden City, NY: The Natural History Press), 1971.
A description of fierce natural phenomena (earthquakes, volcanoes, thunderstorms, etc.) that have brought grief to so many people. The author examines the historical aspects of these events and explains their causes.

Sullivan, William. Continents in Motion: The New Earth Debate. (New York: McGraw-Hill Book Company), 1974.
Reveals how several discoveries confirmed the continental drift theory, and unravels many mysteries of evolution, earthquakes, volcanic eruptions, vanished lands, and recycled oceans.

Tufty, Barbara. 1001 Questions Answered About Natural Land Disasters. (New York: Dodd, Mead & Company), 1969.
Analyzes natural land disasters through a question and answer approach.

Weiss, Malcolm E. Lands Adrift. (New York: Parent's Magazine Press), 1975. Intermediate.
Explains how movements in the earth's crust causes earthquakes.

Other Resources and Instructional Media for Teachers

Ballard, Robert D. Window on Earth's Interior. National Geographic. Vol. 150, No. 2 (August 1976).
Explains movements of the earth's crust from the vantage point of the ocean floor. Includes cross sections of model troughs and other excellent graphics and photos.

Canby, Thomas Y. Can We Predict Earthquakes. National Geographic. Vol. 149, No. 6 (June 1976).
Tells what is presently being done to predict earthquakes and includes diagrams and descriptions of instruments used to detect changes and abnormalities in the earth's crust. (Refers reader to California's San Andreas Fault in the January 1973 National Geographic.)

"Chimbote: A Better Place to Live" (International Zone). UN film. For rental and sale information write to AVMedia, 324 N. Fairfax Street, Alexandria, VA 22314.
After a devastating earthquake, the Peruvian government seeks the assistance of UN agencies, ranging from pre-investment surveys to comprehensive assistance in developing an earthquake-proof master plan.

"Earthquake." UNESCO Courier (May 1976).
An issue devoted to earthquakes, including 14 articles on prevention, quakes in history, measurement, prediction, and warning systems.

Hewitt, Kenneth. "Earthquake Hazards in the Mountains." Natural History. Vol. LXXXV, No. 5 (May 1976).
Outlines the increase of death and destruction from earthquakes where the mountainsides have been deforested and overgrazed.

McDowell, Bart. "Earthquake in Guatemala." National Geographic. Vol. 149, No. 6 (June 1976).
A vivid description and illustrative account of the recent Guatemalan earthquake including maps, pictures, and stories.

Molnar, Peter and Paul Tapponnier. "Cenozoic Tectonics of Asia: Effects of a Continental Collision." Science. Vol. 189, No. 4201 (August 8, 1975).
Explains the continuing effects of the collision of the Indian Plate with the continent of Asia. Includes earthquake examples.

Shapley, Deborah. "Earthquake: Los Angeles Prediction Suggests Faults in Federal Policy." Science Magazine. Vol. 192, No. 4239 (May 7, 1976).
A frank discussion of earthquake precautions and the need for prequake assistance and preparation.

"This Restless Earth: A Study of Volcanoes and Continental Drift." Produced by Schloat Productions of Prentice-Hall Media, Inc.
4-color sound filmstrip with program guide. 72 frames, 9 min., $85 with disc., $95 with cassettes.
An on-the-spot report of a recent volcanic eruption and an in-depth examination of continental drift theory. Includes a number of geological terms and processes.

Wolfert, Ira. "Earthquakes -- Nature's Deep Secret." Science Reader 6 (Pleasantville, NY: Readers Digest Services, Inc.), 1974.
A short article explaining the earthquake as one of Earth's safety measures. Includes discussion of tsunamis and wave effects.

Our Restless Earth

Figures 1-6 show the inside of our earth, the way the plates of its crust have rafted and rifted over the last 200 million years.

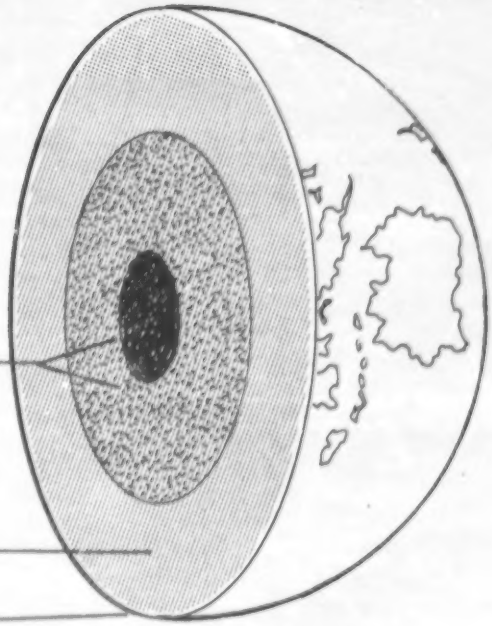

Fig. 1

Fig. 2
Pangaea - about 200 million years ago

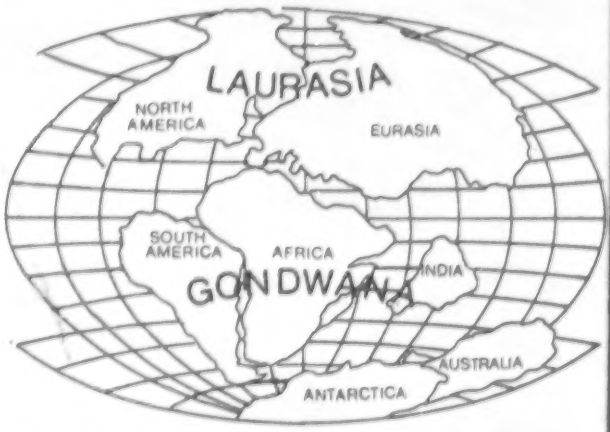

Fig. 3
Laurasia and Gondwanaland - about 135 million years ago

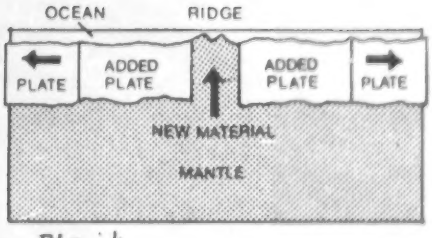

Fig. 4
Plates moving apart

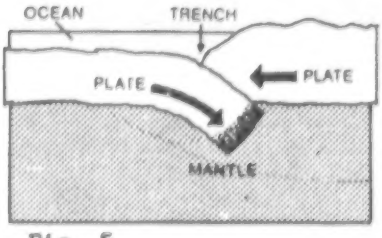

Fig. 5
Plates colliding

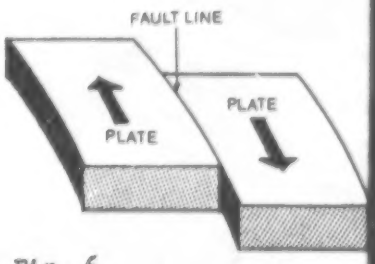

Fig. 6
Plates moving along a fault